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MINERALOGY

OF

NEW-YORK;

COMPRISING DETAILED DESCRIPTIONS OF THE MINERALS HITHERTO FOUND IN THE STATE OF NEW-YORK, AND NOTICES OF THEIR USES IN THE ARTS AND AGRICULTURE.

By LEWIS C. BECK, M. D.

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ALBANY:

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SAMUEL YOUNG,

Secretary of State.

Albany, 1842.

To His Excellency

WILLIAM H. SEWARD,

GOVERNOR OF THE STATE OF NEW-YORK.

I have the honour to submit a Report on the Mineralogy of the State of New-York.

Your obedient servant,

LEWIS C. BECK.

ALBANY, *November* 1, 1842.

PREFACE.

In the arrangement of the Geological Survey of New-York, the part assigned me by the late Governor, the Hon. William L. Marcy, was the examination, scientific description and chemical analysis of its mineral products, or what was understood to be included under the term Mineralogy in its broadest acceptation. This commission was continued by Governor Seward; and the work now presented to the public, is the final result of my investigations.

Desirous of following out to the fullest extent the views which were entertained in regard to the department entrusted to me, the plan which I pursued was, to visit the more interesting mineral districts, for the purpose of obtaining illustrative specimens; to determine with as much accuracy as was necessary, the chemical composition of the most useful and interesting minerals and mineral waters; and finally to present detailed descriptions of all the minerals hitherto found in the State, with notices of their localities and uses.

The results of my labours, in regard to the analysis of useful minerals and mineral waters, will be found in the first part of this work, entitled Economical Mineralogy. In this, my object has been to give an extended and popular account of these products, with such remarks, either directly or indirectly connected with the subject treated of, as I thought would be useful to those who are engaged in the various manufactures dependent on them.

The ores of iron, lead and manganese, gypsum, the water limestones, and the mineral springs, have especially engaged my attention, and full details concerning them will be found in the following pages. Impressed as I have been

with the conviction that these must hereafter become important sources of wealth, I could not doubt the propriety of devoting a large space to their consideration. Those who are acquainted with the difficulties which attend investigations of this kind, will, I hope, at least give me credit for industry in the execution of this part of my trust.

At the commencement of the Survey, few persons, I believe, were aware of the mineral wealth of New-York, or of the number of species which it contains. Such indeed is the extent of territory which the State embraces, and the vast number of mineral localities which it contains, that I could do no more than visit the most important ones. These were of course situated in the great primary regions of the northern and southern counties, although the western ones also afforded rich supplies of species peculiar to their limestone and other formations.

The second part, entitled Descriptive Mineralogy, contains detailed descriptions of the various species hitherto found in New-York, with all their varieties, and notices of their principal localities. In preparing these descriptions, I have freely consulted standard authorities; while remarks upon such peculiarities as our varieties present, have been introduced in their proper place. I may also add, that even in those cases where all the varieties have not yet been found within the limits of the State, I have still given the descriptions of them, in order to render the work as complete as possible in regard to our minerals.

A few species have been introduced, whose occurrence as New-York minerals is still doubtful, or which require further examination; such are Aluminite, Arfwedsonite, Achmite, &c. This course I thought less objectionable than the omission of any species which really belongs to the State. I have also added a list of such American minerals as have not heretofore been found within our limits.

As the crystalline forms of minerals are of great interest, and indeed constitute a very important part of the science of mineralogy, I have paid much attention to the determination of those which have been noticed in this State. The

numerous figures which are here given, from cuts prepared by Mr. Peckham of New-York, will sufficiently attest the richness of our localities in this respect. To render this part of the work convenient for reference, all the figures scattered through the volume have been collected in the form of tables, with the measurements of the several angles. I should state, that in regard to the projections of crystalline forms, Brooke's "Introduction to Crystallography," and Haüy's "Traité de Minéralogie," have been my principal guides. In the measurements of angles, however, I have often adopted the views of Phillips, and other more recent authors, in preference to those of Haüy, for reasons which will be understood by the mineralogist.

As there is some difference in this respect, it may be proper to state, that the scale of hardness which I have followed is that proposed by Mohs, and which is as follows, viz: 1, Talc; 2, Gypsum; 3, Calcareous spar; 4, Fluor spar; 5, Apatite; 6, Adularia; 7, Rock crystal; 8, Topaz; 9, Corundum; 10, Diamond.

The history of the progress of Mineralogy in the State of New-York, is in some measure connected with that of Geology. The former science, however, was cultivated here long before geology assumed the form of a distinct and important branch of knowledge.

Attention was turned to the study of mineralogy in this State about the end of the last century. It is to the late Dr. Samuel L. Mitchill, of New-York, that the science is indebted for the first movement made in its behalf. The first and second volumes of the Medical Repository, published in 1798 and '99, contain "A Sketch of the Mineralogical History of the State of New-York," by that gentleman, which, although meagre in its details, shows that even at that early day the business of collecting materials upon this subject was commenced. In 1799, a Mineralogical Society was formed in the city of New-York, the first in the United States. The circular address of that society was published in the second volume of the Medical Repository. Dr. Mitchill was the president of this association; and, as he himself states, its object was to "arm every hand

with a hammer, and every eye with a microscope." The late Hon. Samuel M. Hopkins, and George J. Warner, Esq., were among the most active members of this society.

That the interest in the science continued to increase, is evinced by the papers which are to be found in several succeeding volumes of the Medical Repository. Among these, I may notice "Observations on the Natural History of the Village of Kinderhook, by the Rev. David Warden;" "Mineralogical Description of the Country near the Walkill and the Shawangunk Mountains in New-York, by Samuel Akerly;" "Descriptions of fluate of lime and oxide of manganese, in the State of New-York, and Mineralogical notices of Onondaga, N. Y."

In 1810 was commenced, in the city of New-York, the "American Mineralogical Journal," by Archibald Bruce, M. D. This work was continued until 1814, and it contributed greatly to advance the cause of Mineralogy in the United States. It contains papers on the mineral productions of New-York, by Drs. Mitchill, Bruce, Akerly and Arnell, and by Mr. J. Griscom.

"The Society for the Promotion of Agriculture, Arts and Manufactures," incorporated in 1793, and whose charter expired by the limitation contained in the act, was revived in 1804, under the name of the "Society for the Promotion of Useful Arts." This Society has published four volumes of Transactions. The first of these contains "A Memoir on the Onondaga Salt Springs and Salt Manufactories in the State of New-York, by Benjamin De Witt, M. D." This is, so far as I am informed, the earliest scientific account of these valuable springs, and is a remarkable paper for the time at which it was written. It is well worthy of being consulted even at the present day.

Although the object of this society, as expressed in its title, was chiefly the promotion of agriculture and the arts, mineralogy was by no means neglected. Being provided with rooms in the Capitol at Albany, they were advantageously situated for the collection of specimens from various parts of the State. A mineralogical cabinet was at length commenced, and through the zeal and activity of some of the members, it was placed on what at that day should be considered a respectable footing.

In 1813, an address was delivered before this Society, "On the Mineralogical Resources of the United States, by T. Romeyn Beck, M. D.", which was published in the third volume of its Transactions. This address contains a notice of the most important mineral productions at that time known to occur in this State.

Professor Cleaveland's Elementary Treatise on Mineralogy and Geology appeared in the year 1816, and it afforded abundant and gratifying proofs of the attention which had been paid to the study of American minerals. The rapid sale of this edition, and the publication of a new and enlarged one in 1822, show the general interest which this science excited. It is much to be regretted that the demand for this work, which has long been out of print, has not been met by new and improved editions. Notwithstanding many later works on mineralogy have appeared, Cleaveland's Treatise is still referred to as one of the standard authorities both in Europe and America.

In 1818, Dr. Mitchill published an edition of the popular "Elementary Introduction to Mineralogy, by William Phillips," with notes and additions on American articles. The object of this reprint was, as stated by the editor, to furnish a more cheap, portable and compendious manual than Cleaveland's work, and which seemed to be demanded in consequence of the increasing attention to this department of science.

During the same year, Professor Silliman commenced the American Journal of Science and the Arts, and which has been continued by him until the present time. This work has probably done more than any other for the diffusion of science in the United States. Of course, Mineralogy has always held a prominent place among the subjects discussed in it, and several of the volumes contain valuable papers relating to the minerals of this State.*

"The Lyceum of Natural History of New-York," which was also formed during the same year, contributed much to promote the cause of mineralogy. A fine cabinet was soon formed by the liberality and industry of some of the

* A list of these papers, up to 1836, will be found in Gen. Dix's Report on the Geological Survey of New-York. *Documents of the New-York Legislature*, 1836.

members. This again excited an interest in others, who in their turn made large additions to the collection.

In 1823, an institution similar to that at New-York was incorporated at Albany, under the name of the "Albany Lyceum of Natural History." By a subsequent arrangement between this body and the Society for the Promotion of Useful Arts, articles of association were agreed upon, and the result was the formation of the "Albany Institute," in 1829. From that time to the present, this society has constantly, though in an unobtrusive manner, been engaged in developing the natural resources of New-York. The extensive and well arranged cabinet of minerals in the Hall of the Albany Academy, the use of which, with characteristic liberality, was granted to the Institute by the Trustees, affords sufficient evidence of the industry and perseverance of its members. This cabinet is particularly rich in regard to the mineralogy of New-York; and from its location at the seat of government, it has probably done much to awaken the interest which is now evinced on this subject in various parts of the State.

This institution was selected as the depository of all the specimens which were collected in the early geological surveys conducted under the patronage of the late Hon. Stephen Van Rensselaer. A liberal donation was also made to it by William Caldwell, Esq., to be devoted exclusively to the purchase of books on Mineralogy, and thus the library was furnished with almost every important work on that branch of science. I am indebted to this valuable collection for the opportunity of consulting several volumes, which I should not otherwise have found it easy to obtain.

Societies similar to that just noticed, were formed in several other cities and villages of the State, and their attention was chiefly directed to the development of the mineral resources of the districts in which they were located.

From the period when the geological surveys were commenced, the progress of mineralogy has been in a measure identified with that of geology. Its importance has always been duly appreciated, and the advance of the one must hereafter keep pace with that of the other.

Such is a sketch of what has heretofore been done for the promotion of Mineralogy in this State. I have been desirous not only to embody in this volume the facts which have been collected during the progress of the Survey, but to post up all the information that was previously possessed in regard to it. With this view, I have consulted all the American books and periodicals which were thought to contain any thing on this subject. Adhering scrupulously to the principle which I have uniformly adopted, I have given due credit for every important fact which has been thus introduced; and to afford those who may be desirous of consulting original papers, the opportunity of doing so, I have, in nearly all cases, given the references in full.

It remains for me to present my acknowledgments for the assistance which I have received during the prosecution of this work. I have already, in my several annual reports, noticed such gentlemen in various parts of the State as afforded facilities in the collection or study of our minerals. To them I again tender my thanks. It is an act of justice to state, that I am under great obligations to Dr. William Horton, who for three years was my assistant. From this gentleman I have constantly received important aid in nearly every department of the work entrusted to me. For the original observations which he has from time to time furnished, I have given him credit under the appropriate heads.

From Dr. Emmons, of the Survey, I have received many favours, such as the loan of interesting specimens for notice and description, and of several maps and cuts. Indeed, it will be seen by an examination of this volume, that I am greatly indebted to all the geologists for interesting facts in regard to the mineralogy of the districts which they examined.

Nor should I omit to state, that for the careful supervision of these sheets as they passed through the press, my thanks are due to Mr. John Patterson, of the State Printer's Office. His scientific attainments have admirably qualified him for labours, the value of which can only be fully appreciated by those who have had the experience of publishing a work of this kind.

LIST

OF THE

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Berthier. Traité des Essais par la voie sèche. Par M. P. Berthier. 2 vols. 8vo. Paris, 1834.

Beudant. Traité Elémentaire de Minéralogie. Par F. S. Beudant. 2 vols. 8vo. 2d Edition, Paris, 1830–1832.

Beudant. Voyage Minéralogique at Géologique en Hongrie pendant l'année 1818. Par F. S. Beudant. 4 vols. 4to. Paris, 1822.

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Brooke. A Familiar Introduction to Crystallography. By Henry James Brooke, F.R.S. &c. 12mo. London, 1823.

Chaptal. Chemistry applied to Agriculture. By John Anthony Chaptal. 12mo. Boston, 1835.

Cleaveland. An Elementary Treatise on Mineralogy and Geology. By Parker Cleaveland. 2 vols. 8vo. 2d Edition, Boston, 1822.

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Daubeny. Report on the present state of our knowledge with respect to Mineral and Thermal Waters. By Charles Daubeny, M.D., F.R.S. Reports of the British Association for the Advancement of Science, 1836.

Dumas. Traité de Chimie appliquée aux arts. Par M. Dumas. 4 vols. 8vo. with a folio atlas. Paris, 1828–1833.

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Eaton and Beck. A Geological Survey of the County of Albany, N. Y. By A. Eaton and T. R. Beck. 8vo. 1821.

Edinburgh New Philosophical Journal. Exhibiting a View of the Progressive Discoveries and Improvements in the Sciences and the Arts. Conducted by Robert Jameson, F.R.S. &c. 33 vols. 8vo. Edinburgh, 1826 to 1842.

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Gairdner. Essay on the Natural History, Origin, Composition and Medicinal Effects of Mineral and Thermal Springs. By Meredith Gairdner, M.D. 12mo. Edinburgh, 1832.

Gordon. Gazetteer of the State of New-York. By Thomas F. Gordon. 8vo. Philadelphia, 1836.

Hall. Catalogue of Minerals found in the State of Vermont, and in the adjacent States, together with their Localities. By Prof. Frederick Hall. 8vo. Hartford, 1824.

Hastings. A Lecture on the Salt Springs of Worcestershire, with an Appendix. By Charles Hastings, M.D., F.G.S. Worcester, 1835.

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New-York Geological Reports. Documents of the New-York Legislature, from 1837 to 1841 inclusive.

New-York Medical and Physical Journal. 9 vols. 8vo. New-York, 1822 to 1830.

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PART I.

ECONOMICAL MINERALOGY.

ECONOMICAL MINERALOGY.

ORES OF IRON.

MAGNETIC OXIDE OF IRON. *Cleaveland.*

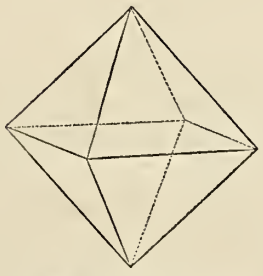
Fer Oxidulé. *Hauy.* — Octahedral Iron Ore. Black or Magnetic Iron Ore. *Jameson.* — Magnetic Iron Ore. *Thomson* and *Dana.* — Octaedrisches Eisen Erz. *Mohs.* — Oxidulated Iron. *Phillips.* — Aimant. *Beudant.* — Magnetic Iron. *Shepard.*

Description. Colour usually iron black, but sometimes bluish or steel grey. Powder always nearly or quite black. The pure ore, when reduced to powder, is attracted by the magnet. Some specimens also possess polarity. This property, so far as my observations extend, belongs to those varieties which have a crystalline or foliated structure, and does not appear to be much influenced by their purity.

Primary form a regular octahedron. Frequently all the edges of the octahedron are replaced by tangent planes. When these secondary faces become so much enlarged as to efface the primary planes, the crystal assumes the form of the rhombic or garnet dodecahedron. Sometimes also the angles of the octahedron are truncated, but rarely to such an extent as to form the cube.

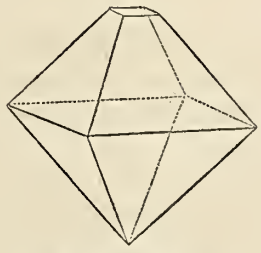
The following crystalline forms occur in this State:

Fig. 1.



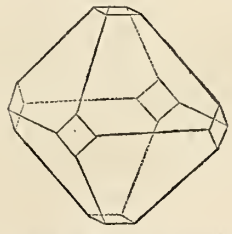
O'Niel Mine, Orange County.

Fig. 2.



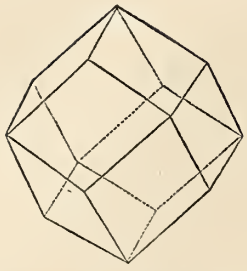
O'Niel Mine, Orange County.

Fig. 3.



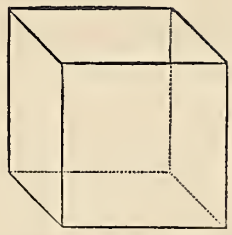
O'Niel Mine, Orange County.

Fig. 4.



Warwick, Orange County.

Fig. 5.



O'Niel Mine, Orange County. (Very rare.)

Cleavage parallel with the primary form. In some cases, as in the specimens from the Rich Iron Mine in Orange county, easily obtained; in others, entirely obliterated by the conchoidal or uneven fracture.

Lustre metallic, but sometimes imperfect; opaque, brittle. Hardness 5.5 to 6.5. Specific gravity 4.74 to 5.09 (*Beudant*); 5.092 (*Thomson*); 4.20 to 5.20 (*Cleaveland*); 4.729 to 5.019 by my own trials on massive varieties from this State.

Not altered by the blowpipe *per se*. But when highly heated, it assumes a brown colour, and loses its power over the magnetic needle. With borax, in the oxidizing flame, it fuses into a dull red glass, which becomes clear on cooling, and often assumes a yellow tint. In the reducing flame, it becomes bottle green.

Insoluble in nitric acid; usually soluble in hot concentrated muriatic acid, but for this purpose the mineral should be reduced to a very fine powder. Sometimes, however, the presence of foreign matters renders it necessary to calcine the ore with carbonate of soda or potash before its solution can be effected.

Distinctive characters. The black colour of its powder, and its strong action upon the magnet, will usually serve to distinguish this species from the specular oxide of iron, which it often resembles.

Composition. This mineral was formerly supposed to be a pure protoxide of iron. It was first proved by Berzelius that it contains both the protoxide and the peroxide of iron. According to that celebrated chemist, the proportions are 31 protoxide to 69 peroxide; but these proportions are subject to great variations.

The value and importance of this ore will be properly appreciated by the single remark, that the Swedes iron, so justly esteemed in the arts, is produced entirely from it.

Geological situation. The magnetic oxide of iron is most generally found in beds or

veins in the primary rocks, especially in granite, gneiss and mica slate. It has also been met with in serpentine, greenstone and hornblendic rocks, and is said to have even been observed in what have been called transition and secondary strata.

In northern New-York, magnetic iron ore is almost as widely diffused as are the mountains of granite and of gneiss, in the counties of Warren, Essex, Clinton and Franklin. The rocks in which this ore is found in these counties, however, differ somewhat in their characters. In some parts of Essex, they are chiefly composed of quartz and hornblende of a fine granular structure, while in others they are granite or sienite made up almost entirely of dark coloured feldspar, containing masses of labradorite, and in some places a small proportion of pyroxene. In Clinton county, the rock in which this ore is found is a granite composed of quartz and feldspar, quartz and hornblende, or feldspar and hornblende, sometimes with scales and seams of mica forming gneiss. In the county of Franklin, the rocks which accompany the magnetic iron are said to contain much more hornblende, which is frequently observed in crystalline masses in the walls of the beds and among the ore.*

The magnetic iron ore in these counties is, with scarcely an exception, in what are usually termed *beds*, or deposits of variable widths and unknown depths running parallel to the course of the stratification, when the rock is stratified. The general direction of these beds is north-northeast and south-southwest; but when subject to local variations, the course is north and south, or northeast and southwest. Sometimes, however, this ore occurs in large masses in the rock, without any regular parallelism of the sides, as is the case in Essex county. And lastly, it is occasionally disseminated in particles in the rock, apparently without any connexion with a bed or vein.†

In Orange county, where the magnetic oxide of iron is very abundant, it is always found in the granitic gneiss or gneissoid granite so common in the highlands. It lies in beds and layers in this rock, and has the same line of bearing and dip. Where it exists in layers, they are from one inch to twenty feet in thickness, and in some places the layers of the ore alternate several times with those of the rock. But the ore sometimes occurs in masses, the magnitude of which has never been ascertained.‡

The same general description will apply to the geological situation of the magnetic oxide of iron, as found in the counties of Putnam, Saratoga, Washington, Herkimer and Lewis. And from a review of all the observations which have been made on this subject, there is little doubt that the position and geological relations of this important mineral are entirely similar in all parts of the State in which it has been found.

Geographical range. From what has just been said in regard to the geological relations of the magnetic iron ore in this State, a tolerably correct idea may be formed of its geographical distribution.

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* See the Reports of Dr. Emmons and Mr. Hall. *New-York Geological Reports*, 1837.

† Mr. Mather thinks, that in Putnam county, the magnetic iron ore occurs in true veins.

‡ Dr. W. Horton's Report on the Geology and Mineralogy of Orange County. *New-York Geological Reports*, 1839.

Commencing with the southern part of the State, we first observe beds or veins of magnetic iron ore crossing the line between New-Jersey and New-York, at or near the southern extremity of Orange county; and they occur abundantly in various parts of the primitive ranges which traverse this county in a northeasterly direction. Crossing the Hudson, this ore is found in abundant, though less numerous, deposits in Putnam county.

In proceeding from these primary ranges in a northern direction, the magnetic iron gives place to other ores of this metal, until we reach the granitic ranges of Saratoga, Washington, Warren, Herkimer and Lewis; in each of which counties, beds of the former ore are found of greater or less extent. They also abound in various parts of Hamilton, Essex, Clinton and Franklin counties, while they are rarely met with in Jefferson and St. Lawrence.

Before proceeding to describe the particular localities of this important ore, it may be proper to remark, that so far as my observations extend, it possesses great similarity of composition as well as of combination. In a great majority of instances, it is both mechanically and chemically mixed with silica. In several cases, however, other minerals are associated with it, as hornblende, feldspar, pyroxene and mica. It sometimes also contains small proportions of titanic acid, a fact which is proved not only by chemical analysis, but by the small crystals of metallic titanium which are found in the slag produced during the process of reduction. Sulphur, in the form of iron pyrites or bisulphuret of iron, is moreover a common associate of the magnetic iron ore, a fact of importance to the iron master, as it often occurs in such large proportion as to prove injurious to the resulting iron. In such cases the exposure of the ore to the combined agency of air and moisture, causes the decomposition of the pyrites, and the consequent production of sulphate of iron, which is at length entirely removed by rains. A fine illustration of the correctness of this remark will be found in a heap of ore which was some years since raised from a part of the great Philips vein in Putnam county, and which has thus been freed from the iron pyrites originally associated with the ore in such a large proportion as to render it almost valueless.

There are few foreign matters usually mixed with magnetic iron ore that appear to exert any injurious effect upon it in the process of reduction, unless they are in considerable proportion. Sulphur is probably the most common of all these substances, but many of our most valuable ores contain small portions of it. Quartz, hornblende, feldspar, pyroxene and mica, are only so far objectionable as that they require larger quantities of fluxing materials and an increased expenditure for fuel. Even titanic acid, which some have thought to be exceedingly deleterious, does not in reality seem to be so, unless the proportion be large; for it is found in the slags of some of the most largely and profitably worked furnaces, both here and abroad. These facts are especially worthy of notice, because they lead to the conclusion that the quality of an iron depends perhaps as much upon the mode of manufacture employed as upon the kind of ore.

Chemical analyses of iron ores, and indeed of most other ores, are usually open to the objection that specimens of greater purity are operated upon than the average produce of the locality. It is in this way that incorrect opinions have sometimes been formed in regard to the value of ores, which have at length proved to be the cause of loss and perhaps ruin to

many individuals. This, however, is no fault of the chemist; for the specimens sent to him for his experiments, instead of being the average of the produce of the mine, are almost always the purest and best which have been obtained. In all these cases, perhaps the true value of a chemical analysis consists in the determining the kind of ore, and the nature of the foreign matters mixed with it; but the proportion of these matters in large quantities of the ore, and indeed the true economical value of the ore can only be learned by a careful inspection of the locality. And it is this consideration which renders it important that, in the study of minerals with reference to their uses in the arts, the trials of the laboratory should be united with the observations of the geologist.

The purity and consequent value of the magnetic iron ores may in general be very easily determined in those cases where the questions in regard to their quantity, and the ease of conducting mining operations, have been previously settled. For this purpose, it is only necessary to take a known quantity (say an ounce) previously reduced to powder, and then to subject it to the continued action of a strong magnet. The pure magnetic oxide will thus be separated from the foreign matters with which it was mixed; and from its weight, the proportion which it bears to the whole may be at once ascertained. This, it will be observed, is the principle of the separating machine, which is so advantageously employed in many parts of Northern New-York.

I shall now proceed to describe in detail the more important localities of the magnetic oxide of iron, commencing at the southern part of the State, and passing from thence towards the north.

Rockland County. Specimens of magnetic oxide of iron, sometimes possessing polarity, are not unfrequent in the granitic ranges of this county. I have a specimen from the vicinity of Ramapo, which has a specific gravity of 5.019; but this ore has no where been found in beds or veins of any considerable extent.

Orange County. This county contains very abundant and rich localities of the magnetic oxide of iron. It is doubtful, indeed, whether the quantity which exists here does not exceed that found in an equal area in any part of the world. The towns of Monroe, Warwick and Cornwall, are the most remarkable in this respect.

Stirling Mine, or *Stirling Mountain*. This is a vast deposit of iron ore which occurs in a mountain of moderate elevation, rising at the south end of Stirling pond in the town of Monroe. From the excavations which have been made in various parts, there can be no doubt that this deposit of ore is three miles in length. The mine is said to cover a surface of more than thirty acres, by survey. Over a part of this area the ore is bare, while in others it is covered by soil and rock of from six inches to five feet in thickness.

The ore from this mine is usually granular, but it occasionally occurs in octahedral crystals, and is associated with ilmenite, crystallized green hornblende, pyroxene, green mica, quartz and flesh-coloured feldspar. It is feebly magnetic, and is also sometimes mixed with iron pyrites, to which perhaps the peculiar character of the metal obtained from this ore is to be ascribed; being, according to Mr. Townsend, intermediate between *cold* and *hot short*.

The Stirling iron ore yields about fifty per cent of iron in the blast furnace. The amount annually raised has been from 500 to 2000 tons. The mean of this gives 137,000 tons as the total amount obtained from this mine. It has been largely used for casting cannon, and for making bar iron.

This mine was discovered in 1750, and named after Lord Stirling, who was then the proprietor of the soil. It was sold, and a blast furnace was put into operation by Messrs. Ward and Colton, in 1751. At the outlet of Stirling pond are still to be seen the ruins of the furnace at which the manufacture of iron was carried on with great activity previously to the revolutionary war. It was at this furnace that the iron was smelted which was used in the construction of the chain laid across the Hudson river at West-Point.*

The *Belcher Mine*, discovered in 1792, is about one and a half miles southwest of the Stirling mine, and at the southern termination of the mountain in which that is found. The ore has been worked about 115 feet in width, without finding a rock wall on either side. It yields about forty-eight per cent of *cold short* iron, and is well adapted to the making of bar iron by the blooming process. This mine is supposed to be a prolongation of the Stirling mine.

Red or *Spruce Swamp Mine*, in the same town with the preceding, is nearly three miles south of Long Mine. Its ore is magnetic, and largely mixed with iron pyrites, so much so indeed that it has been but little used. For the same reason also it decomposes rapidly when exposed to the air. The surface of the mine is thus covered with a powder of an iron black colour.

Crossway Mine, upon the Townsend estate, is 400 or 500 yards southwest of the Mountain Mine, to be presently noticed. This bed is described as being fourteen feet thick, and having been wrought sixty-five feet in depth, and one hundred and fifty yards in length. The ore and walls very nearly vertical; associated with hornblende, epidote, mica and feldspar. About 28,000 tons of ore are said to have been obtained from this mine. The resulting iron is moderately *red short*.†

Paterson Mine. This is situated about three quarters of a mile southwest from Long Mine, to be hereafter described. The general direction of the bed is the same as in the latter, and the minerals which are found in it are also similar. The ore is massive, and breaks into columnar fragments. It is not only attracted by the magnet, but possesses magnetic polarity, approaching to the variety called native loadstone. It does not differ in chemical composition from that of the Long Mine, except perhaps in containing a larger proportion of silica. About 10,000 tons of this ore have been used, but the mine has not been recently worked. It yielded about fifty-six per cent of good *red short* iron.

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* The principal facts above stated in regard to the Stirling Mine, were communicated by Peter Townsend, Esq. one of the oldest, most intelligent and enterprizing iron masters in our country. Much valuable information was also obtained from the same gentleman concerning the other iron mines of this county. The statements of Mr. Townsend are embodied in Dr. Horton's Report on the Geology and Mineralogy of Orange county (*New-York Geol. Rep.* 1839), which I shall have frequent occasion to quote.

† Dr. Horton's Report on the Geology and Mineralogy of Orange county. *New-York Geological Reports*, 1839.

Mountain Mine, Antoine Mine, Conklin Mine and *New Mine,* are a group from twenty-five to fifty rods northwest and north from the Paterson Mine, belonging to the Messrs. Townsend. The lie in nearly parallel beds; the ore of all apparently similar, being a rich black magnetic oxide, possessing polarity. About 5000 tons of ore have been taken from these mines. The iron obtained from it is *red short.* The associated minerals are hornblende, feldspar and pyroxene; the last of which, is laminated, and often very beautiful.*

Long Mine. This mine is situated about five miles southwest of Southfield furnace. The ore occurs in gneiss rock, and follows the general direction and dip of the strata, and is never at right angles to them. It has been traced in a direction nearly north and south for the distance of a mile or more. The average width of the deposit is sixteen feet, to make up which there are two parallel layers, with a thin waving stratum between them, from four to twelve inches thick. The associates of the ore are hornblende, pyroxene, quartz, mica and feldspar, the proportions of which are subject to great variation.

The ore itself, in a state of the greatest purity, is of a bluish black colour, and has minute grains of quartz disseminated through it, which causes it to give fire with steel. It breaks into columnar fragments, and being of a granular structure, is without much difficulty reduced to a coarse powder; and when in this state, it is strongly attracted by the magnet. Its average specific gravity is 4.885; and with the exception of the silicious particles, it is entirely soluble in hot concentrated muriatic acid.

Upon analysis, this ore was found to have the following composition, viz:

Protoxide of iron,	25.40
Peroxide of iron,	70.50
Oxide of manganese,	1.60
Silica or quartz, and loss,	2.50

These proportions of protoxide and peroxide of iron are equivalent to 68.50 per cent of metallic iron. The ore is said to yield, on the average, 62 per cent, in the large way.

According to Mr. Townsend, the Long Mine was discovered in 1761, by David Jones. About 37,500 tons of ore have been taken from it, being an average of 500 tons annually. The iron obtained from it is remarkably tough, clean and strong, and has been much used for steel, cannon, muskets, wire and fine malleable iron.

Greenwood Mine, is two miles southeast of Greenwood furnace in the town of Monroe. It is in granitic gneiss. Three layers of ore, separated by a few feet of rock, are exposed, of which the middle one is nine feet in thickness. These layers dip to the southeast, lying conformably with the gneiss. The ore is mostly compact and hard, and it contains a considerable proportion of iron pyrites. Hence it requires to be roasted before it can be advantageously used in the furnace. Its associates are quartz, hornblende and mica.†

The *Rich Iron Mine* is situated five miles southeast of Monroe Works, and is on the

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* Dr. Horton's Report on the Geology and Mineralogy of Orange county. *New-York Geological Reports,* 1839.

† Ibid.

McFarlane tract. It has not been extensively wrought, although there are evidences of an abundant deposit. The ore is strongly magnetic, possesses polarity, and is remarkable for the ease with which it cleaves in the direction of the primary octahedron. Large cleavage crystals may be obtained. Associated with the ore are mica, hornblende, pyroxene, magnetic and common iron pyrites.

The following are the results of my analysis of a specimen of this ore, which had the octahedral cleavage and an iron black colour:

Protoxide and peroxide of iron,	96.50
Silica and alumina,	3.50

Forshee Mine. This is an extensive bed of magnetic iron ore, about a quarter of a mile southwest of the O'Niel Mine. The whole hill, which is more than a quarter of a mile in length and nearly as much in width, appears to consist of alternate layers of rock and ore, the latter forming a large proportion. The general direction of the deposit is nearly north and south. Some of the layers of ore have a compact structure, while others are made up of what is called *shot ore*, often quite free from iron pyrites. Rarely it is found crystallized in the form of octahedrons. In some parts of the mine, the ore has a cavernous or cellular structure, as if some of the original constituents had undergone decomposition and been dissolved out. This form of ore passes into an earthy oxide of iron, having a dark brown colour, and closely resembling umber.

The following is the composition of the cellular variety of the magnetic oxide of iron from this mine:

Protoxide of iron,	44.10
Peroxide of iron,	52.75
Silica and alumina,	3.15
Oxides of titanium and manganese,	traces.

The constituents of the umber, according to my analysis, are as follows, viz:

Peroxide of iron,	68.00
Peroxide of manganese,	8.50
Silica and alumina,	6.50
Water,	17.00

The last, therefore, is a hydrous peroxide of iron, and is undoubtedly the result of the decomposition of iron pyrites.

Associated with the iron ore at this mine, are delicate veins of amianthus, red garnet, brown tremolite, calcareous spar, serpentine and mica.

It may be added, that the ore from the Forshee Mine is highly valued by the iron masters in this part of the State, especially those portions of it which are granular and cavernous. The latter variety is sufficiently free from iron pyrites to be used without the preliminary operation of roasting.

O'Niel Mine. This is about a quarter of a mile northeast of the preceding, and is a vast bed of the magnetic oxide of iron. The ore is generally hard and compact, but is often traversed by seams which are studded with crystals having the form of the regular octahedron, which is occasionally modified, and rarely passes into the form of the cube. (See Fig. 1, 2, 3 and 5.)

This mine has been extensively worked. The ore contains iron pyrites, and requires to be roasted before it is used by the smelter; but it yields a good iron of the *red short* variety. Its immediate associates are white calcareous spar, which is abundant, rose coloured garnet, green coccolite, dark coloured pyroxene and massive hornblende; amianthus in delicate fibres, serpentine, and probably arragonite also occur.

The O'Niel ore is strongly attracted by the magnet, and possesses polarity. The following is its composition:

Protoxide and peroxide of iron,	95.75
Silica and alumina,	4.25

The *Clove* or *Wilks Mine*, which is the most westerly of the great iron ore deposits now wrought, is situated about a mile south of the village of Monroe. The ore is strongly attracted by the magnet, and is sometimes granular and pure, at others it is largely mixed with iron pyrites. It makes *red* or *hot short* iron, and generally requires roasting before it is used. At the south end of the mine, which has been opened about 500 feet, the ore occurs in the form of a black powder, which is here called *fine* or *soft* ore, and is probably the result of the decomposition of iron pyrites. Large quantities of this variety have been obtained, and it does not require the ordinary roasting process.

According to Dr. Horton, the solid ores of this mine are in layers having the direction and dip of the rock in which they occur. The layers are from a few inches to a yard or more in thickness. The immediate associates of the ore are mica, hornblende, quartz, feldspar, asbestus, occasionally carbonate of lime, a kind of serpentine or soapstone, and perhaps, though rarely, chrome-iron ore in minute octahedrons.

The following are the constituents of one of the purest specimens of the Clove ore, by my analysis:

Protoxide and peroxide of iron,	98.90
Silica and alumina,	1.10

But the granular magnetic ore is usually mixed with iron pyrites, as above stated.

It may be added, that masses of well characterized hematite are found on the surface, in the immediate vicinity of this mine.

The remaining deposits of the magnetic oxide in this county are much less important than those previously described. They are principally in the town of Cornwall.

A bed of the magnetic oxide of iron occurs about one or two hundred yards east of the reservoir at West-Point. Its quantity is not known, but it has been traced, at short intervals for some distance in a southerly direction towards *Meek's Mine*, on the western part of Bear hill, southwest of Buttermilk falls. The ore of the latter mine is said to be titaniferous.*

* Mather. *New-York Geological Reports*, 1839.

Kronkite's Mine, on the farm of Richard Kronkite, Esq. is about four and a half miles south-southwest of West-Point. There are two veins or beds of ore, separated by a sheet of rock, which are from a few inches to ten feet in thickness. They have been traced from fifty to eighty rods, and have a range north-northeast. About 800 tons of ore were taken from this mine nearly forty years since, which is said to have yielded iron of a good quality.

There is another unimportant mine on the east side of Bear hill in this town, and one or two in the vicinity of Round pond. To these may be added the *Smith Mine*, which was opened in 1828, and is about a mile and a half south of Kronkite's Landing, between the Crow's Nest and Butter hill. The bed or vein of ore, which is strongly magnetic, is three or four feet thick, and dips with the gneissoid rocks in which it is contained. It has, however, been abandoned.*

The *Forest of Dean Mine* is situated about five miles west of Fort Montgomery, on the Hudson. The vein is from thirty to thirty-six feet in width, and has been opened for the distance of one hundred and fifty yards or more. The ore is attracted by the magnet, and is usually free from sulphur. When employed alone, it is said to afford a *cold short* iron; but when mixed with the ore from the next mine, it yields an iron of good quality for bars and for castings.

This mine is one of the first that was opened in this county, and perhaps in the State. It supplied a furnace on the spot for twenty-one years previously to 1777, when it was abandoned. Since that time, the ore has been used at Queensborough and other places.

The *Queensborough Mine* is another extensive deposit of the magnetic oxide of iron in the vicinity of the preceding. It has been long opened, and much ore obtained from it.

Green's and *Titus' Mines*. These are situated on Deer hill, near the village of Canterbury. The ore, which is contained in the gneiss rock, is granular, easily broken, and is associated with quartz, feldspar and actynolite. The ore is said to be of good quality, but the extent of the deposit is not known.

In the vicinity of the preceding locality, the same ore is found associated with ilmenite and zircon.

Putnam County. Several extensive and important deposits of the magnetic oxide of iron occur in this county.

The *Philips Vein*, as it has been called, has been traced, at short intervals, for about eight miles, and is thought by Mr. Mather to be continuous throughout the whole of that distance, except where it is interrupted by dykes and transverse heaves of the strata. It follows the crest of the east ridge of the Highlands; its width varying from three to thirty feet.† Several mines have been opened on this vein, and some of them are now worked. The following are those most worthy of notice.

The *Philips Mine* is a deposit of the magnetic oxide of iron fifteen or twenty feet in width. It is situated on the Cold Spring turnpike in Philipstown, about eight miles southeast of

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* Mather. *New-York Geological Reports*, 1839.

† *New-York Geological Reports*, 1839.

Davenport's inn. It is contained in the gneiss or hornblendic gneiss rock, and follows its line of bearing and dip. The ore is usually quite compact, and sometimes mixed with iron and copper pyrites. In some parts of this mine, which is a mile or more in length, the ore is so highly charged with iron pyrites as to render it unfit for working, without the preliminary process of roasting.

There are here apparently three distinct deposits of this ore, scarcely differing from each other, except in the proportion of iron pyrites which they contain. However much they may resemble veins when on the surface of the rock, wherever they have been opened to any extent, they are found to be parallel with the general stratification.

Hornblende, both massive and in imperfect crystals, crystallized sphene, graphite, iron and copper pyrites, carbonate of lime, green and blue carbonate of copper, and hyalite, are found in immediate association with this ore, or in the rock in which it occurs.

The *Denny Mine* is about three quarters of a mile south-southwest of the preceding, and seven miles east of Philips' mill. It is situated on one of the crests of the eastern ridge of the Highlands. The ore is usually compact and tolerably pure, but it is often largely mixed with silica. It is strongly attracted by the magnet, and also possesses polarity. It is easily reduced to powder, which, as usual, is black, unless when largely mixed with foreign matters. The deposit is in beds or veins in gneiss, which, however, have a higher inclination than is usual. Mr. Mather has correctly remarked, that the rocks on each side of the principal vein are more or less traversed with thin veins of ore; and it has been suggested, that the ore has been injected into the cracks and crevices of the rock when broken by some upheave.

The constituents of one of the compact specimens of this ore, are as follows:

Magnetic oxide of iron,	89.00
Silica, &c.	11.00

Besides silica, feldspar, and rarely carbonate of lime and asbestus, are associated with this ore.

This mine has been worked about thirty years; and Mr. Mather states that about 600 tons of ore are annually obtained from this and the other openings in the immediate vicinity. It is used at the furnace at Cold Spring, and at some of the furnaces in Orange county, where it is mixed with the ore from the O'Niel and Forshee mines.

The *Coal Grove Mine* is about a mile and a half south-southwest of the Denny mine. The vein, which is in gneiss, is narrow at the surface, but widens in descending. The ore is represented as being of good quality, and well adapted to use in the forge. The mine is nearer to the furnace and Cold Spring Landing than any of the preceding.

To these may be added the *Kemble Mine*, a short distance north-northeast of the Coal Grove Mine, and the *Gouverneur Mine*, four miles east of the Philips manor house, both on the Philips vein; neither of which, however, have been much worked.

The *Townsend Mine*, which occurs in the Simewog hill in the town of Southeast, has been opened for nearly half a mile, and has a course about northeast and southwest. This is one of the earliest discovered and most extensively worked mines in this part of the State.

Large quantities of ore have been raised here, and there seems to be still an abundance of it in various parts of the vein. But in consequence of its distance from the furnaces now in operation, the working of it has been abandoned. Mr. Mather remarks, that he has no doubt that this vein is at least two miles in length, with an average width of six feet. The ore is strongly attracted by the magnet, and is quite similar to the ores found in the deposits just described. The associated rocks are gneiss and hornblendic gneiss.*

A locality of the magnetic oxide of iron occurs on the farm of Mr. Tilly Foster, about two and a half miles southeast of Carmel. The ore forms a large part of a hill about a hundred yards long and ten to forty feet broad. There is here, probably, an extensive deposit of ore.

To these it may be added, that a bed of the same ore was, many years since, opened on Anthony's Nose on the Hudson river, but it contained much iron pyrites, and was not, it is believed, thought to be of much value.

In proceeding from this range in a northern direction, I am not aware that any considerable deposits of magnetic iron ore are known to exist, until we reach the county of Saratoga. It here occurs in a mountain about half a mile west of the Hudson, and a short distance north of Jessup's Landing.† It is on lands belonging to Thomas I. Porter, Esq. and was discovered about the year 1826. It is now opened to the depth of twenty feet or more, and the vein is said to have been traced for more than a mile. The ore is said, moreover, to furnish a remarkably hard and tough iron, and to possess those *steely* properties which are ascribed to the Duane ore in Franklin county, and of which I shall say something hereafter.

Herkimer County. A bed of the magnetic oxide of iron was discovered, during the year 1839, on the land of Mr. Willit Congdon, three or four miles northeast of Salisbury Centre. It has, however, been traced on the adjoining lots for three quarters of a mile. The mine has not yet been sufficiently opened to reveal its character. From one to two hundred tons of ore had been obtained from it at the time of my visit, (in 1840.) The ore is compact, attracted by the magnet, and possesses polarity. It is associated with silica. The walls of the bed are gneiss. The situation of the mine, as at present opened, is by no means advantageous for drainage, which is a matter of no trifling importance.

The discovery of iron ore in this part of the State, is one of great importance. There are here all the facilities for its manufacture, and no iron is made in its vicinity. It is, moreover, interesting as being the nearest point to the Mohawk valley, where the magnetic iron ore, in any abundance, has hitherto been found.

Lewis County. Iron sand is abundant on the banks of Moose and Black rivers, and the massive magnetic ore has been noticed near Louisburg furnace, at the High falls of Black river, at Lyondale, and on the road from Harrisville to the Natural Bridge; but it has not yet been found in sufficient abundance to be worked.‡

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* Mather. *New-York Geological Reports*, 1839.

† For the facts concerning this deposit of ore, I am chiefly indebted to Dr. J. M. Allen, late superintendent of the salt works in Onondaga county.

‡ Vanuxem. *New-York Geological Reports*, 1840.

A specimen of the magnetic sand from the banks of the Moose, gave, upon analysis, the following results, viz:

Silica and titanic acid,	5.16
Magnetic oxide of iron,	94.84

Washington County. An extensive bed of magnetic iron ore occurs in the town of Fort-Ann, four miles north of the village of the same name; the ore, however, is largely mixed with black garnet, granular and crystalline hornblende. There are also similar deposits near Mount-Hope furnace in Fort-Ann. The ore is magnetic, and sometimes exhibits polarity. It lies in beds, sometimes pure, and sometimes intermixed with garnet, coccolite or hornblende. Some other localities are noticed by Mr. Mather.*

The following is the composition of a specimen of magnetic iron ore from Fort-Ann:

Protoxide of iron,	42.26
Peroxide of iron,	53.69
Insoluble matters,	4.05

Warren County. The magnetic oxide of iron is found on French mountain, three miles south of the village of Caldwell, and some expense has been incurred in the excavations which have been made. The ore is strongly magnetic, and possesses polarity. It is usually massive, but octahedral crystals are also occasionally obtained. The associates are white and red feldspar, of which large and handsome cleavages are abundant. These sometimes contain grains of quartz. As a locality of iron ore, this is of very little consequence. Aside from the great difficulty of access, there is as yet no evidence that the ore exists here in any quantity.

At Warrensburgh, near the East river, twelve miles from the village of Caldwell, this mineral has been found in beds of considerable extent, and has there been worked by the bloomery process. In one of these beds the ore was at first of good quality, but it gradually changed its character when the mining was continued, until at length it became unfit for use.

This ore has a granular structure, the grains being of various sizes and colours, and evidently consisting of different minerals. It is easily reduced to powder, and the grains are sometimes held together by so feeble a cohesion, that they may be separated by a slight blow of a hammer. The whitish or transparent particles are usually about the size of a pin's head, are scratched by fluor spar, and effervesce with acids. Small scales, of a steel grey colour, which soil the fingers and give a blackish trace upon paper, are also disseminated through the mass.

From this description it is evident that the results of the analyses of this ore must be more or less discordant. The following is the mean of several trials:

Magnetic oxide of iron,	70.80
Carbonate of lime,	25.00
Plumbago,	3.00
Silica, and loss,	1.20

* *New-York Geological Reports*, 1841.

The separating machine, or washing, would be required to render this ore fit for the forge. It would undoubtedly be valuable for the high furnace.

On the land of Mr. Harris in Schroon, is a vein of magnetic oxide of iron, six or seven feet wide, which may be traced a number of rods. It is on the west side of Paradox lake. It is a coarse grained and pure ore, being mixed only with a small quantity of quartz.

Beds of the same mineral exist also in the towns of Athol and Luzerne, and in Hyde township.* The ore is usually pure, although that at the latter locality is sometimes mixed with sulphur. With little trouble they would all furnish a sufficiently pure iron.

Deposits of the magnetic oxide of iron are also known to occur in the town of Hague, but their extent has not to my knowledge been determined. They cannot, however, at present be of much value.

Essex County. This county is abundantly supplied with rich and extensive deposits of the magnetic oxide of iron, several of which are profitably worked.

In the vicinity of Ticonderoga there occurs an ore of this kind, which consists of grains of various sizes, and which have a brilliant lustre, resembling polished steel. The precise locality is unknown. As it was so peculiar in its appearance, I was induced to analyze a portion of this ore, when it was found to be a nearly pure magnetic oxide of iron, containing only a very small admixture of silica and iron pyrites. It is strongly magnetic, and possesses polarity.

There is an important deposit of the magnetic oxide in the town of Crown Point, known as the *Penfield Ore Bed.* It is extensively worked, and the ore is of an excellent quality. It is attracted by the magnet, and possesses polarity. The structure is usually compact, but the ore easily reduced to a coarse powder, in which form it is subjected to the action of the magnetic separating machine to free it from the silica with which it is mixed. One of the purest specimens of this ore had the following composition:

Magnetic oxide of iron,	92.97
Silica and alumina,	5.93

On the immediate bank of Lake Champlain, near Port Henry in the town of Moriah, and known in the vicinity by the name of *Crag Harbour*, is a deposit of magnetic iron ore of about twelve feet in thickness. It dips to the southwest at an angle of about 35° or 40°, and is overlaid by a stratum of hornblende, which mineral is also a constant associate of the ore. It is probably owing to this that the resulting iron is hard and brittle, and unfit for many of the uses to which that metal is applied. This difficulty might perhaps be removed, by mixing the ore with one of a different kind, and by a proper adjustment of the flux. The advantageous situation of this deposit, and its probable extent, render it worthy of some effort to accomplish so desirable an end.

The Crag Harbour ore is of a black colour and semi-crystalline structure; is tough and with difficulty broken into fragments. It is powerfully attracted by the magnet, and ordinarily

* Emmons. *New-York Geological Reports*, 1839.

possesses feeble polarity. It is almost always accompanied by hornblende, and good specimens of black mica may be obtained in its immediate vicinity. Thin veins of iron pyrites are also frequently observed. The specific gravity of this ore is 4.729. The following is its composition, viz:

Protoxide of iron,	24.50
Peroxide of iron,	66.80
Insoluble matters, silica, &c.	8.70

About a mile and a half southwest of the preceding, is another bed of this ore, with similar associates. The ore is of a greyish black colour, and contains grains of iron pyrites disseminated through it, which renders the operation of roasting necessary, previously to its introduction into the furnace. It is granular, friable, and is said to furnish a softer iron than the preceding, although it is less fusible.

Cheever Mine. This is an important deposit of magnetic ore, situated about a mile and a half from Port Henry, near the line of the town of Westport. It is in the primitive rock, has a course about northeast and southwest, and is from seven to ten feet in thickness. It has been opened for at least 900 feet, and more or less ore taken out at various points. About 3000 tons are annually obtained from this mine. The ore is made up of grains loosely united, of a shining black colour, and it is highly magnetic. The associates are hornblende, a little feldspar, and sahlite or hypersthene.

This ore is used at the furnaces at Port Henry, and is said to yield good iron.

The *Sanford Mine*, is found in the town of Moriah, about six miles west of Port Henry. This is an extensive deposit of ore, and it has been quite largely worked; but it seems now to have given place to some of the other mines with which this region abounds. The ore is usually granular, but sometimes highly polished cleavages of some size may here be obtained. Like the preceding, it is strongly attracted by the magnet, but is not usually polar. The associates of the ore are somewhat peculiar, and probably exert an important influence upon the quality of the iron obtained from it. Veins of delicate fibrous amianthus or byssolite are not uncommon, and many specimens are studded with small but perfect six-sided crystals of phosphate of lime. These were observed in abundance in a heap of this ore near the Port Henry furnace. This is probably one of the most troublesome associates of iron ore, especially when it exists in such comparatively large proportions as it seems to do in some parts of the Sanford Mine. The carbon used in the furnace causes the decomposition of this phosphate, and the liberation of phosphorus, which, during its contact with the iron, must injure its quality.* I believe it has been usual to wash this and the other ores found in this

* It may not be unimportant to add, that phosphorus, so frequently contained in iron ores, and furnished even by the ashes of the combustible, does not injure the quality of iron, unless it exists in a comparatively large proportion. According to Karsten, a compound of 10,000 parts of iron and 50 of phosphorus, gives an iron of good quality, which resists the blow of a hammer. A compound of 10,000 iron and 75 phosphorus, yields an iron which frequently breaks by a blow; while an iron consisting of 100 phosphorus and 10,000 iron, cannot be bent to a right angle.

vicinity, previously to their being used in the furnace. In the present case, this process seems to be especially indicated.

About a mile west of the Sanford Mine, is the *Barnum Mine*, which has apparently been largely worked. The ore is strongly magnetic, is often compact, and almost entirely free from foreign minerals, but is in general mixed with quartz. Black hornblende is also one of the associates of this ore, and some of the specimens of this mineral, from the walls of the mine, are of large size and of great beauty. Masses of labradorite were also found strewed on the surface of the ground near this mine.

Hall's Mines. These are deposits of magnetic iron ore, about a quarter of a mile north of Hall's inn. They are similar in their general characters to the other deposits in this vicinity, more nearly resembling beds or alternations in the strata of primitive rock than true veins. The ore is magnetic, and its principal associate is quartz, veins of which sometimes traverse it, and occasionally exhibit crystalline forms. A reddish feldspar, of some beauty, is sometimes found here; and I also noticed, in the second opening, specimens of pyroxene, hornblende, and the crystals of phosphate of lime, similar to those found at the Sandford Mine. Brown zircon, exhibiting some interesting crystalline forms, was found in a small vein of white quartz running through the ore.

The Hall ore is highly esteemed at the furnaces in this region, and is said to yield an iron of an excellent quality. It is usually washed before it is employed by the iron smelter.

It should be observed, that a vein of pulverulent black matter runs through the Hall Mine, probably consisting of peroxide of iron. I also obtained a few specimens of jaspery iron ore, or an intimate mixture of the peroxide with quartz.

In the vicinity of the preceding are the *Everest* and *Green*, and the *Everest Mines*, and others, which are all deposits of magnetic ore, of greater or less extent, and exhibit the same general appearances. At the Everest Mine, however, a circumstance occurs, which, although not very uncommon, is nevertheless worthy of notice. It is the occurrence in the same vein or bed, and as it were passing into each other, of the black magnetic oxide and the red or specular iron ore. There can, I think, be little doubt that the latter was originally a magnetic ore, which, by those agencies which are believed to have been subsequently operating, has been brought to its present state of oxidation.

But the most extensive deposits of the magnetic oxide of iron in this county, occur in the town of Newcomb. These have been already so minutely described by Dr. Emmons, that I shall notice them briefly.

Sandford Mine. This is situated on the western face of a hill which rises 600 or 700 feet above Lake Sandford, and is about two miles south of the village of McIntyre. The ore is usually granular, with a crystalline structure in the mass, but is rarely compact; it is sometimes friable, forming the *shot ore* of the miners. The surface masses of ore are magnetic, but seldom possess polarity. In descending, the structure becomes slaty, and the layers have an easterly dip. These layers are often intermixed with hypersthene and granular feldspar.

The shape of this vein or deposit of ore, which has been exposed, is nearly triangular; and from excavations which have been made, it is ascertained that its length is sixteen hundred

and sixty-seven feet, and its width five hundred and fourteen feet. According to Dr. Emmons, if we merely estimate the amount of ore at the depth of two feet from the surface, we shall find it to be 6,832,734 tons, a large proportion of which may be raised without the use of powder. This entire deposit is said to be free from iron pyrites, and from all substances known to exert an injurious influence on iron. The associated minerals are hypersthene, labradorite, hornblende and common feldspar.*

In a specimen of this ore which I examined, I found 92.15 per cent of magnetic oxide of iron, and the remainder earthy matters, principally silica.

There are outcrops of ore, similar in character to that just described, at the distance of a mile and a half, and on the opposite side of the lake, in the direction of Hill's island. Dr. Emmons supposes these to be prolongations of the Sandford vein, and if so, its whole length is two and a half miles.

In the immediate vicinity of the present works is a deposit of magnetic oxide of iron, which has been called the vein of *coarse grained black ore*, from the colour and coarsely granular texture of the ore. The grains are larger than those of the Sandford ore. The extent of the vein has not been accurately determined, but it has been traced in the direction of its strike 3168 feet, while its width has been ascertained to be more than 700 feet. Hypersthene, labradorite, serpentine in small masses, and occasionally iron pyrites, are found associated with this ore; the iron obtained from which is remarkable for its toughness and ductility.†

In addition to the preceding, there is in this immediate vicinity a vein of fine grained ore, more or less mixed with iron pyrites. This vein has been traced 7742 feet, and is about 70 feet in width. There are also veins of less extent near the village of McIntyre. One is on the west side of Lake Henderson, about three quarters of a mile from the works. It is a fine grained ore, and is thought to be worthy of exploration. There is another on the west side of Lake Sandford, which is quite extensive; and still another on the east side of the Sandford hill, which is supposed to be a continuation of the vein of the same name. Its extent is not known.

There are one or two apparently important deposits of magnetic oxide of iron in the vicinity of Brant lake.

Clinton County. This county is peculiarly rich in localities of the magnetic oxide of iron. Among these, the most extraordinary is that which is known by the name of the Arnold Bed; the ore from which has long enjoyed a high reputation, that analysis shows to be well deserved. Indeed, I think it may be safely asserted, that it is one of the purest and best ores that is now known.

The *Arnold Mine* is situated in a mountain of gneiss, about three miles northwest of Clintonville. It has been traced nearly three quarters of a mile, in a direction varying but little from north and south. There are three parallel veins which constitute the mine, and the ore

* Emmons. *New-York Geological Reports*, 1840.

† See the experiments of Prof. Walter R. Johnson, quoted by Dr. Emmons. *New-York Geological Reports*, 1840.

from these differs somewhat in its characters. In one of them it is granular, and of a blue-black colour. When reduced to grains, it is strongly attracted by the magnet; but none of the masses which I have tried, possess polarity. It is free from foreign admixture, except a minute portion of quartz. Its specific gravity is 4.977. The following is its composition, according to my analysis:

Protoxide of iron,	27.00
Peroxide of iron,	71.50
Quartz (mechanically mixed) and loss,	1.50

The average width of this vein is four or five feet. It is, as well as the rest, crossed by a dyke of greenstone.

By the side of the black vein, there is a vein of *light blue* granular ore, and one of a *grey* variegated colour. They are separated from each other by a few feet of rock. The blue ore is almost destitute of metallic lustre, and is not magnetic, although it bears a general resemblance to the magnetic ores. Its powder is red, thus indicating an ore in the highest state of oxidation, which is also confirmed by the results of its analysis. Its composition is as follows:

Peroxide of iron,	98.00
Silica,	2.33
Lime,	traces.

The greyish ore is easily reduced to grains, and often has spots of a green and blue colour. It does not possess the least magnetic properties, and the powder has a brownish red colour, like the specular ores. I suppose both these last ores to have acquired their high state of oxidation by some decomposition which has taken place subsequently to the original deposition of the mineral. The composition of this ore is as follows:

Peroxide of iron,	97.00
Insoluble matters,	2.83
Oxide of manganese and lime,	traces.

The width of the blue vein varies from two to eight feet, which is also about the width of the grey vein. According to Dr. Emmons, calcareous spar, in opaque masses, forms a large proportion of the gangue of these ores, through which also fluor spar, in green or purple grains, is sparingly disseminated.

The *Finch vein* is a continuation of the Arnold vein. The ore is grey and black, and has been much used in the vicinity of Clintonville; but it is not worked at present.

About two or three miles west of the preceding, is the *Palmer Mine*. This was opened several years since; but, according to Dr. Emmons, the principal vein, which is thirty-five feet in width, was not worked until 1839. The geological relations of this deposit are similar to those of the Arnold Mine, but the accompanying rock is of a more crystalline character. Large masses of feldspar and of quartz frequently occur, mica being more sparingly disseminated. The ore is black and magnetic, but so largely mixed with foreign minerals, principally silica, as to render it necessary to subject it to the process of washing, or to the action

of the magnetic separating machine. With this previous preparation, it is considered one of the best ores in this district.

Cook Mine. This traverses a hill three miles northwest from Clintonville. There are here two parallel veins, only four or five feet distant from each other; the one of which is not more than two feet wide; the other, more recently discovered, is thirteen feet wide. There are also three other veins, parallel with the last, one six feet wide, another three, and another two feet. The ore is black, sometimes granular and soft; at others, compact, or in firm masses. It is strongly attracted by the magnet, and possesses polarity. The gangue of the ore is quartz, black mica and hornblende, and these are so intimately mixed with the ore as to require their separation by washing, or by the magnetic machine. It then yields iron of an excellent quality.*

Baltic Mine. This, although a mile and a half from the Cook Mine, is to be considered as a part of the same deposit, the connexion being traceable by surface ore. Several openings have been made in the immediate vicinity of each other, and there is probably a large quantity of ore. It is, however, more or less mixed with iron pyrites. The gangue is entirely similar to that of the preceding.

Rutgers Mine. This is situated about eight miles west of Clintonville, in one of the primary ranges. The vein is about ten feet wide, and the gangue or mineral matter associated with the ore is said to be peculiar, and is thought by Dr. Emmons to be new. The course of this vein is parallel with that of the Arnold and Cook veins; but as the ore does not yield so good an iron as some others, it is not at present worked.

Winter Mine. This has been thought to differ in its character from the other deposits of ore in this district, as it appears like a thick plate covering several square rods of the rock with which it is associated, or, as Dr. Emmons expresses it, as if it was deposited horizontally on the rock, like an overflowing melted mass of lava. This gentleman states, however, that it presents no appearances which, in reality, differ from those attending the ordinary veins. The layer or mass of ore just noticed, is about one hundred feet in length by forty in breadth, and two or three feet in thickness. This was found to be underlaid by masses of lean ore, exhibiting the parallel bands or stripes which characterize other veins. The deposit is every where traversed by transverse dykes; and since the removal of the rich superficial mass of ore, there does not seem to be much inducement for working it.

To those now described may be added the *Mace*, the *Burt*, the *Jackson* and the *McIntyre* veins, or mines, which occur in the same district, but which are probably of secondary importance.

The *Skinner Mine*, situated about three miles north of the Saranac river, and about seven miles from Cadyville, is represented as an inexhaustible deposit of the richest magnetic ore. It is coarsely granular, has a dull metallic lustre, and is but slightly magnetic. It yields a tough and valuable iron.† The accompanying rock is a reddish granite; but the ore, according

* Emmons. *New-York Geological Reports*, 1840.

† B. S. Roberts, in the Report of the Commissioners to survey the route of the Ogdensburgh and Champlain railroad. *Documents of the New-York Legislature*, 1841.

to Dr. Emmons, has mixed with it a greenish mineral, resembling phosphate of lime and hornblende.

In the same district are the *Conger Mine* and the *Sailly and Averil's Mine*, which, however, do not require particular descriptions.

Franklin County. Although the magnetic oxide of iron has not heretofore been found in such abundance in this county as in some of those which are contiguous to it, several deposits are already known to exist, and there can be no doubt that others will hereafter be discovered.

In the vicinity of Malone, a bed of this ore was opened many years since, from which several hundred tons of good ore have been obtained. A fine deposit is noticed by Dr. Emmons, as occurring near Miller's in the town of Franklin, and another on a ridge near the outlet of Tupper's lake.

The *Deer River ore* has a resinous lustre, and its masses are intermixed with hornblende. Its gangue is coarsely crystallized hornblende, accompanied with large imperfect garnets, and some black mica.

The *Duane Bed* is represented as a mixture of coarse and fine ore. It is a rich ore, intermixed with particles of granular greenish-white feldspar.

But the most interesting ore of iron in this county, is that which is known as the "*Steel ore*." The deposit from which this is obtained, is situated in the Old Military township, No. 9, adjoining the town of Duane. The ore is of a black colour, is strongly attracted by the magnet, and possesses polarity. The associates are principally hornblende, quartz and feldspar. There is considerable variation in the width of the vein. It has been opened for several years.

I analyzed this ore some years since, and found that it did not differ from common magnetic oxide of iron. It has also been assayed, as we are informed, by Thomas B. Clemson, Esq. who gives the following as the result:*

Iron and Scoria,	15.42
Iron alone,	12.90
The part possessing the properties of steel,	64.50

This ore possesses considerable interest, from the fact that it is said to yield, directly, by the process of smelting, a substance possessing all the properties of manufactured steel. By some, these properties are thought to be inherent in the ore itself, while Dr. Emmons has advanced the opinion that the iron obtained from the ore is converted into steel during the process of tempering.†

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* MS. communication from James C. Duane, Esq. of Schenectady. See also the Report of the Commissioners to survey the route of the Ogdensburgh and Champlain rail-road. *Documents of the New-York Legislature*, 1841.

† See Dr. Emmons' Report on the "Steel Ore" to the Assembly of the State of New-York, March 10th, 1841. Also the communication of B. S. Roberts, in the Report of the Commissioners to survey the Ogdensburgh and Champlain rail-road. *Documents of the New-York Legislature*, 1841.

On this subject I will only add, that there is probably nothing peculiar in this ore, and that the same steely properties will be found to belong to many of our magnetic iron ores. The important point which I think still remains to be determined is, whether the steel thus obtained from the Duane ore is of such an uniform texture as to produce good cutting instruments, without some subsequent process. If correct ideas have heretofore been entertained in regard to the nature of steel, the properties for which it is most esteemed are due as much to mechanical as to chemical agencies. The metal yielded directly by the process of smelting, may possess some of the characters of steel; but I should doubt, whether, without the mechanical operations which are ordinarily employed, it would stand the test to which good steel is to be subjected. It is not improbable that this ore may be well fitted to the manufacture of steel, which will hereafter render it valuable; but I can not yet give entire credence to the statements which have been made concerning the direct mode in which the "best steel" may be so easily and so directly obtained.

St. Lawrence County. By far the largest proportion of the iron ores now known in this county, belongs to the species to be hereafter described; but there are some deposits of the magnetic oxide of iron, which deserve to be briefly noticed.

In Pierrepont, a bed of magnetic oxide of iron has been worked to some extent, and the ore is thought to be abundant. Ore of the same kind is also found in the town of Canton, on the land of the Hon. H. Van Rensselaer.

Chamont Ore Bed. This bed, according to Dr. Emmons, was several years since extensively worked. It is situated in a hill of gneiss, about four miles west from the point where the Albany road crosses the Oswegatchie river. The ore is black and highly magnetic, but is largely mixed with quartz. It is thought, however, to be sufficiently pure.*

Magnetic oxide of iron is often observed in the gneiss rock in the western part of this county, sometimes accompanied with hornblende, and sometimes without that associate. About seven miles south of Potsdam, a bed of this ore is found, which supplied a forge at that village. I have also obtained good specimens from the town of De Kalb, but the mineral has not heretofore been found there in any quantity.

Jefferson County. The deposits of magnetic oxide of iron in this county, as in the preceding, are few in number, and limited in extent. The town of Alexandria furnishes some localities, but they are of little importance.

There is a deposit of this ore, apparently abundant, on the farm of P. Wicks, two and a half miles southwest of the village of Oxbow. What adds to the interest of this, is the fact that it is quite near to a bed of specular iron ore, which, as we shall presently see, is abundantly diffused through this, as well as the preceding county.

I have thus noticed the principal localities of the magnetic oxide of iron in this State; and have traced the deposits of this ore, with some interruption, from the extreme southern part, in a northern direction, nearly to the Canada line, and thence westwardly upwards of one

* *New-York Geological Reports*, 1840.

hundred miles. Throughout this whole extent, the ore is tolerably uniform in its character, and differs in value chiefly in consequence of variations in the proportions of foreign matters with which it is mixed. There are very few cases in which positively injurious substances occur. The deposits usually have a northern and southern direction, and are parallel with, and not at right angles to, the strata in which they occur. Whether their formation has been cotemporaneous with that of the rocks in which they occur, whether they have been separated by chemical affinity during the process of consolidation, or by electric agency, are questions, the discussion of which does not properly belong to this department.

I shall defer some general remarks concerning the manufacture of iron, until I have completed my account of the remaining ores of this metal.

Magnetic Iron Sand.

This variety occurs in the form of small crystals, or fragments of crystals, or in grains constituting a sand. It is usually of a dark bluish black, or iron black colour, is strongly attracted by the magnet, and may thus be completely separated from the earthy matters with which it is mixed. It is often found to contain oxide of titanium, chromium, and it is frequently associated with grains of garnet.

Some New-York localities of iron sand have already been given in the preceding account of the magnetic oxide. It may be useful, however, to bring together all the information that we possess, in regard to this variety.

We are informed by Mr. Mather, that magnetic iron sand is found in small quantities along the whole coast of Long Island, where the surf beats the shore. In some localities, there are layers of it two or three inches thick. It is most abundant after storms.

The same substance is found on the banks of the Hudson near West-Point, and on the banks of many of the streams in the Highlands. It also occurs in great abundance at Port Henry and elsewhere on Lake Champlain; on the shores of Lake Ontario, in Monroe county; on those of Geneva lake and Lake Erie; and on the banks of the Moose river, at Lyondale, in Lewis county. It is sometimes in such abundance as to be used by the iron smelter.

In regard to the occurrence of this sand, it may be observed that the theory commonly received is, that it is the result of the disintegration of rocks which are contiguous, and which abound in crystals of magnetic iron. This is said to be the case at West-Haven in Connecticut, where it occurs on the beach which forms the margin of the seashore, while contiguous to the beach is a formation of chlorite slate, abounding with minute crystals of magnetic iron. These crystals, liberated from the slate, and broken by the action of the waves, constitute the magnetic sand of the beach.* Now although the explanation here given may be applicable to this locality, it can hardly be considered as generally applicable. The iron sand is frequently found at a great distance from known beds of magnetic ore, and moreover its chemical composition is oftentimes so very peculiar, that it is impossible to account for its occurrence in the mode just described.

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* Silliman. *Cleaveland's Mineralogy. Second Edition.*

SPECULAR OXIDE OF IRON. *Cleaveland.*

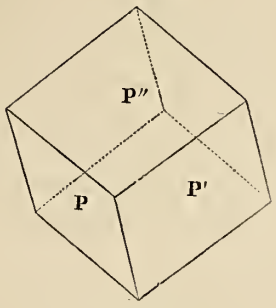
Fer Oligiste. *Hauy.*—Rhombohedral Iron Ore. *Jameson.*—Specular Iron Ore. *Thomson.*—Specular Iron. *Phillips, Dana and Shepard.*—Oligiste. *Beudant.*—Rhomboedrisches Eisen-erz. *Mohs.* (It includes the true Specular Iron, Iron froth, Iron Mica, Red Hematite, Red Clay Ironstone, Red Siliceous Ironstone, Red Ochre, &c.)

Under the above name are now included many varieties which pass into each other by almost imperceptible gradations, so that it is impossible to draw the line of specific distinction between them.

Description. Colours dark steel-grey bordering on iron-black, iron-black and brownish red. The powder in all cases is some shade of red, usually cherry-red, or reddish brown. It is sometimes feebly magnetic.

Occurs regularly crystallized; in granular, lamellar and fibrous distinct concretions; massive, disseminated, reniform, botryoidal, stalatitic and globular. The primary form is a rhombohedron. P on P′ = 86° 10′, P on P″ = 93° 50′.

Fig. 6.



The mineral sometimes assumes the form of an octahedron, sometimes of a triangular dodecahedron, with its apices truncated, either very deep, or near the apex.

Lustre from splendent to dull, and is metallic or semi-metallic. Fracture conchoidal or earthy. Usually opaque, but sometimes thin laminæ are faintly translucent. Hardness 5.5 to 6.5. Specific gravity 4.8 to 5.3 (*Jameson*); of a crystallized specimen from Sweden, 5.251 (*Haidinger*).

Infusible by the blowpipe *per se*, but melts with borax, and forms a green or yellow glass, like magnetic oxide of iron. It is soluble in hot muriatic acid.

Distinctive characters. From the magnetic oxide of iron, which it often resembles, it may be distinguished by its red powder. and feeble action on the magnetic needle.

Composition. The specular oxide of iron, when pure, is a peroxide of iron, containing in 100 parts, 69.34 of iron, and 30.66 of oxygen. It seldom occurs in nature in this state of purity, but is generally mixed with silica, alumina, lime, &c.; and upon the proportion of these must depend the value of any particular variety of ore. In a table exhibiting the composition of various specimens of the specular oxide, according to the analyses of Berthier and others, the amount of peroxide of iron varies from 28 to 99 per cent, the latter proportion being found only in a specimen from the department of Moselle, in France.* It may be

* Berthier. *Traité des Essais par la Voie Sèche*, II. 223.

stated, as a sufficient evidence of the value of this ore, that in the island of Elba it has been worked since the time of the Romans, and that the iron obtained from it has always been held in the highest estimation.

Geological situation. The specular oxide of iron is usually found in beds and veins in the primary or the older transition rocks. It is not met with in any abundance in the secondary formations.

According to Dr. Emmons, this ore is found in the State of New-York in two geological situations. In the first, it is associated with primary limestone, as occurs in many cases in the town of Edwards, St. Lawrence county; in the second, it has gneiss or some other primary rock below and the Potsdam sandstone above, as in the Kearney and Parish mines in the same county.*

As I intend, under the name of Specular Oxide of Iron, to describe localities of ores which are often known by other names, it may be useful here to notice the different varieties, now included under the present species.

Common Specular Iron, has a metallic appearance, is of a steel-grey or iron-black colour, and frequently occurs in the form of crystals. Characteristic specimens are found in several deposits in St. Lawrence county.

Micaceous Specular Iron. This resembles the preceding in its colour, but is composed of thin shining laminæ, or scales, applied to each other. Its powder is a dark red.

Red Iron Stone, is destitute of a metallic appearance, and includes *red hematite*, found in masses, stalactites, kidney-form balls, &c., and having a brownish red colour and fibrous structure; the *compact* and *ochrey red iron ores*, which are massive and have a compact texture; and *iron froth*, composed of scaly friable parts, which soil strongly, and have a colour between cherry and brownish red. To these may be added the *Lenticular Clay Iron ore*, so abundant in the western part of the State.

Geographical range. This ore is found almost exclusively in the northern and western parts of the State. In the county of St. Lawrence it takes the place of the magnetic oxide, while it becomes less abundant as we proceed to the eastern boundary of the State. Again, in the counties bordering on the Erie canal, the lenticular variety is met with in layers of various degrees of thickness, from Herkimer to Monroe.

I shall now describe some of the most important deposits of this ore.

Essex County. Near the summit of Mount Defiance, in Ticonderoga, is a narrow vein of the red hematite in a granitic rock. It is associated with quartz, and sometimes passes into the variety known by the name of *jaspery iron*. It is peroxide of iron mixed, and chemically combined, with variable proportions of silica. It is used both as a paint, and as an ore for furnishing metallic iron. About thirty tons of the mineral are said to have been obtained from this locality, but the difficulty of access renders it almost valueless.

* *New-York Geological Reports*, 1840.

In Crown-Point, this ore, although not found in separate deposits, is nevertheless often associated with magnetic oxide of iron, and its formation is no doubt due to the alteration of the latter mineral. Thus in the Saxe Ore Bed, the red ore, which has been changed from the magnetic oxide to the peroxide, exhibits the fibrous structure of the common hematite. The same transformation may be observed in some of the mines in the town of Moriah, and in perhaps a still more striking manner in the celebrated Arnold Mine in Clinton county.

St. Lawrence County. Numerous deposits of the specular oxide of iron have already been made known in this county. The most valuable are those known by the names of the *Kearney* and *Parish Ore Beds.* These beds are situated about four and a half miles southwest of the village of Gouverneur. Although they are distinguished by the names above given, they are not more than 80 or 100 rods distant from each other, and are undoubtedly parts of one vast deposit, which has been traced at least a mile in a northern and southern direction. A large quantity of ore has been taken from the present openings, and it yields iron of a good quality. The deposit of ore seems to be a bed resting on the primitive rock, and overlaid by the oldest of the sandstones.

The specimens from the Parish and Kearney beds present several varieties; such as the slaty, like the micaceous ore; hard and compact; jaspery and semi-crystalline; the blades, although small, having the high lustre of the Elba ore. The powder of all these has a bright red colour, and soils the fingers like red paint. Associated with the ore are crystals of brown spar, carbonate of iron, calcareous spar in dodecahedral crystals, and rarely sulphate of barytes. A vein of so-called arragonite, (most probably calcareous spar,) also passes through the bed, from which fine specimens, both crystallized and fibrous, may be obtained.

The most abundant ore, however, is that which has a brownish red colour, compact texture, and a dull earthy aspect. The specific gravity of an average specimen of this is 4.855, and the following is its composition, viz:

Peroxide of iron,	96.52
Silica, alumina, &c.	3.48

The ore, when properly selected, is of good quality, and yields in the large way fifty per cent of pig iron, of which about 2600 pounds are said to yield a ton of wrought iron. A mixture of bog iron ore improves the quality of the iron obtained.

Several important deposits of the specular oxide of iron are found in the towns of Hermon and Edwards. The ore is often in large brilliant plates, and is associated with crystallized quartz of the dodecahedral form, and with carbonate of iron.

At Gouverneur Bow there are several unimportant localities of this ore, some specimens from which have the high lustre so characteristic of this mineral when in a crystallized form. It is here usually in small veins, with associates similar to those observed in the beds previously noticed.

Beds of this ore are said also to occur in the towns of Fowler and Scriba. In Canton there is a bed which was formerly worked, but is now abandoned; and there is also a deposit in

Pierrepont, a specimen of which, according to my analysis, proved to be peroxide of iron, with from three to four per cent of silica.

Jefferson County. *Sterling Ore Bed.* This is probably the most important deposit of the specular oxide of iron in this county. It is situated in the town of Antwerp, five miles southeast of the village of Oxbow. The ore is principally of the compact variety, but is sometimes in crystalline plates with a high metallic lustre. It is often much mixed with siliceous matter. Dodecahedral crystals of quartz abound in the ore, and in the sandstone which accompanies it. The rare cacoxenite is also found in the crevices of the ore; and carbonate of iron, in well defined crystals, is occasionally met with.

On the farm of Mr. P. Wicks, about two and a half miles southwest of Oxbow, there is a somewhat abundant deposit of this ore; but it is largely mixed with foreign matters, has a slaty structure, and is not thought to be of much value.

There is a bed of the specular oxide of iron, known as the *Theresa Bed*, about four miles east of the High falls in this county. The ore is similar to that from the Parish and Kearney mines, and the deposit is also in sandstone.*

These, together with one on or near Muscolunge lake, are the only localities of this ore worthy of notice in this county.

Lewis County. The specular oxide of iron has been discovered, within a few years, about two miles from the Lewisburg furnace. The hard red ore, with what is called the red froth, is associated with sandstone; and below these are the crystalline ore and its calcareous associates, the latter reposing upon the primary rock.†

Near the Natural Bridge is a deposit of a mixture of red iron ore, chlorite, plumbago, &c. which contains usually about fifty per cent of peroxide of iron. This was strangely enough supposed to be silver ore. It is scarcely necessary for me to say that I could not detect the slightest trace of that metal in any of the specimens which I examined. It may, however, prove to be of some value as an ore of iron.

Lenticular Clay Iron Ore.

This mineral, which is also known by the name of Argillaceous Iron Ore, is now generally considered to be a variety of the specular oxide of iron. It is very interesting to us, in consequence of its great abundance in the western part of the State. There seem to be two distinct beds or strata of this ore in the protean group of Mr. Vanuxem, arranged in lines parallel to each other, extending from the county of Herkimer to the Genesee river. These beds, liable however to some interruptions, are usually about twenty feet from each other, and vary from one foot to two and a half feet in thickness. The width of the strata is exceedingly variable

This ore consists of lenticular or flattened grains of various sizes, which apparently have been made to cohere by the pressure applied to the mass. It frequently contains joints or disks of the encrinite, and fragments of other organic remains. Its usual colour is brownish

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* Emmons. *New-York Geological Reports*, 1840.

† Vanuxem. *New-York Geological Reports*, 1840.

red, its powder being more red. It is very friable, soils the fingers, has but little lustre, and is often studded with minute grains of iron pyrites. The specific gravity of a fair specimen from Wolcott in Wayne county, is 3.740. All the samples which I have examined effervesce freely in acids, which is probably due to the admixture of carbonate of lime. By some its formation is ascribed to the decomposition of carbonate of iron; and by others, to that of iron pyrites. The infiltration of water, acting in a slow and imperceptible manner, is supposed to be the cause which has produced this decomposed form of the ore.

In Herkimer County, there are from one to two beds of the lenticular clay iron ore. They are found on all the water courses, which have cut through the shales resting on the millstone grit of Eaton.*

In Oneida County, numerous pits have been opened in the towns of New-Hartford, Kirkland, Vernon, Westmoreland and Verona. There are three beds of the ore in this county, varying from twelve to twenty inches in thickness. They have been long and extensively worked, and the ore, although containing a less proportion of metallic iron than many other ores, is nevertheless highly valued by iron smelters. Previous roasting improves its quality, and is indeed often quite essential to its successful reduction, in consequence of the presence of iron pyrites.

Madison County. Passing westward from Verona, the iron ore beds are either buried under the alluvial, or more probably washed away, excepting on the land of Thomas Donnelly in the town of Lenox. It exists in solid masses a short distance below the surface, and is a very pure ore, the carbonate of lime having been removed by solution in water.†

An ore entirely similar in its external characters to that of Verona, has also been found at one or two places on the shores of Oneida lake; but from some cause or other, it seems not to have yielded good results in the furnace.

This ore has been found in Cayuga County, in the creek near Martville, and also south of Hulme's sandstone quarry; but it has not yet been obtained in large quantities.

In Wayne County, a stratum of the lenticular ore has been found extending through it, and at about two miles distance from Lake Ontario. In the immediate vicinity of Wolcott, there is a bed of about a foot in thickness. About a mile north of the village is a furnace, which is now supplied with ore from the eastern part of the town, where the stratum of ore is about three feet in thickness.

Near the mouth of Salmon creek in the town of Sodus, this ore was formerly worked; but it is largely mixed with carbonate of lime, and is less valuable than that from other localities.

Pits for the raising of this mineral have also been opened in the vicinity of Ontario furnace, which is situated upon Bear creek about two miles south of the ridge. This ore is said to

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* Vanuxem. *New-York Geological Reports*, 1838. † Ibid.

yield from 33 to 35 per cent of metallic iron, which, however, is brittle, and is employed only for large castings. By mixture with bog iron, or the magnetic oxide, a better result is obtained. "This ore requires a high heat for melting, and it consumes one third more of charcoal than the harder ores. There is always produced a considerable quantity of carburet of iron, in thin bright scales or leaves, exactly resembling plumbago."*

It may be stated that this ore, and the rock immediately associated with it, often contain nodules of massive and crystallized sulphate of barytes of a flesh red colour. The crystalline forms, sometimes highly modified, are not, in any specimens which I have seen, sufficiently perfect to be accurately projected.

The following are the results of an analysis of a specimen of the lenticular clay iron ore from Wolcott:

Peroxide of iron,	51.50
Carbonate of lime,	24.50
Carbonate of magnesia,	7.75
Silica,	6.00
Alumina,	7.50
Moisture and loss,	2.75

Several localities of this ore occur in the County of Monroe; but it is nowhere, I believe, converted to use in the process of reduction. At Rochester, a stratum of about a foot in thickness is observed at the Lower falls, and from thence specimens of ordinary purity may be obtained. It is entirely similar in its external characters to the ore from other localities. The following is its composition:

Peroxide of iron,	42.93
Carbonate of lime,	28.33
Carbonate of magnesia,	10.40
Silica and alumina,	17.66

This ore has not been found, between the Genesee and Niagara rivers, in a regular stratum. It may, perhaps, be found again west of the latter stream.

The preceding are the principal localities of the specular oxide of iron heretofore found in this State. In point of abundance, it cannot be compared with the magnetic oxide, nor is it equal to that ore in purity. It, however, yields an iron which is highly valued for various purposes, especially for castings; and when mixed with other ores, it greatly improves their quality.

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* Dr. G. W. Boyd. *New-York Geological Reports*, 1838.

HYDROUS PEROXIDE OF IRON. *Thomson.*

Limonite. *Beudant* and *Shepard.* — Brown Oxide of Iron, and Argillaceous Oxide of Iron. *Cleaveland.* — Rhombohedral Iron Ore. *Jameson.* — Hydrous Oxide of Iron. *Phillips.* — Rhomboedrisches Eisen-Erz. *Mohs.* — Brown Iron Ore. *Dana.* (It includes Brown Hematite, Brown Ochre, Umber, Yellow Iron Stone, Brown Clay Iron Stone, and all the varieties of Bog Iron Ore.)

Under the general name of Hydrous Peroxide of Iron, or Limonite, are now included the several species and varieties above mentioned; for the reason, as in the case of the Specular Oxide, that all these minerals run into each other in such a manner as to baffle all attempts to give distinctive characters.

Description. Colours various shades of brown, sometimes yellowish. Powder yellowish brown. Without action on the magnet.

Very rarely occurs crystallized; it usually presents stalatitic, botryoidal or mammillary forms, having a fibrous structure; also massive, and sometimes earthy. When crystallized, the primary form is said to be a right rectangular prism, but its occurrence in crystals has been doubted by many mineralogists.

Hardness, when pure, 4.5 to 5; in its impure form, its hardness is very variable. Specific gravity 3.922 (*Haidinger*); 3.37 to 3.94 (*Beudant*).

Infusible by the blowpipe, but gives out water by calcination; and most of the varieties become black or reddish black, and magnetic. With borax, it melts into a green or yellow glass; and it is soluble in heated nitro-muriatic acid.

Composition. Limonite is supposed to be a hydrate of the peroxide of iron, the proportions being 85.30 peroxide of iron, and 14.70 of water; so that in its purest form, 100 parts of the ore contain 59.70 metallic iron. There are, however, generally found in it various other substances, either in mixture or in combination; as silica, alumina, oxide of manganese, and some ore of zinc. Titanium is also occasionally associated with it. It is sometimes mistaken for the oxide of manganese, but the chemical characters are sufficiently distinctive.

This mineral is here very widely and abundantly diffused. It is one of the most important of our ores, and furnishes a considerable proportion of the iron at present produced in this State.

I shall now notice some of the principal localities of this ore, commencing in the southern part of the State, and proceeding towards the north and west.

Richmond County. Five or six miles southwest of the Quarantine, on the road to Richmond village, there are beds of brown hematite, of some extent. The ore is sometimes massive, and at others consists of spherical grains of various sizes, united by a ferruginous cement, and known by the name of *shot ore*. It often has a shining surface, and appears to be mixed and coated with talc. Brown and yellow ochres are also found here, and are used by the inhabitants as paints.

The following is the composition of a specimen of the shot ore :

Peroxide of iron,	72.37
Silica and alumina,	15.43
Water,	12.20

Dungin's Mine, a short distance from the preceding, has ores of a similar character.

In consequence, chiefly, of the scarcity of fuel, no furnaces have been erected in the immediate vicinity of these deposits. The ore, however, has been transported in considerable quantities, and is said to afford a valuable iron.

On Long Island brown hematite is often met with in detached masses, but no important or extensive beds of it have as yet been made known.

On the Island of New-York, bog iron ore is of frequent occurrence, but the quantities of it are entirely too small to answer any valuable purpose. It is most usually reddish brown, cellular, and contains much oxide of manganese.*

Westchester County. A bed of hematite, apparently of a good quality, is found on the farm of Mr. James Ammerman, about a mile and a half north of the county poor house, and four or five miles east-northeast of Tarrytown. Several tons of ore have already been obtained from this bed, and it is thought to be extensive. It is associated with white limestone; and Mr. Mather states, that this range of rock reaches the banks of the Hudson, a short distance below Dobbs' Ferry.†

Bog iron ore occurs a mile and a half south of Sing-Sing, but it has heretofore only been obtained in quantities sufficient for cabinet specimens.

Again, the varieties of this species, usually denominated *Red Ochre* and *Red Chalk*, occur in some abundance on the farm of H. I. Cruger, Esq. in Cortlandtown.

Rockland County. Thin veins of the *hematitic* ore, probably associated with oxide of manganese, are found on the banks of a small stream, two miles west of the village of Ramapo.

A dark brown, nearly black, oxide of iron, occurs near Haverstraw, which deserves only to be noticed from the fact, that it was mistaken for the oxide of manganese; in consequence of which, the bed of ore was represented as being of great value. When subjected to the action of the blowpipe, the mineral becomes strongly magnetic. It is easily fusible with borax, but does not communicate a violet tinge to it.

Orange County. There are in this county several localities of limonite, in its several varieties. It rarely, however, occurs in sufficient abundance to be worked as an ore.

Two and a half miles west of the village of Canterbury, in the town of Cornwall, is a mine of limonite, belonging to Mr. Thomas Townsend. The ore occurs massive, and in a variety of imitative forms. In some parts of the bed it is filled with organic remains. Large quan-

* Pierce and Torrey. *Cleaveland's Mineralogy. Second Edition.*

† *New-York Geological Reports*, 182[illegible]

tities of this ore have been raised, and although intermixed with earthy matters, it yields an excellent iron. The balls and masses of true hematite are mixed with a ferruginous powder, which sometimes results from the decomposition of the associated strata of rocks. Washing is, therefore, necessary to prepare this ore for the iron smelter.

This bed of limonite lies in the limestone rock, which reposes on the millstone grit. The limestone and hematite can be traced across this town into that of Monroe, where we meet the magnetic oxides already described. They are observed a quarter of a mile north of the Wilks or Clove Mine, and in many places between this and the Townsend Mine, a distance of at least ten miles.*

Hematite is also found along the whole western side of Bellvale mountain, and in many places along the Warwick valley, to the New-Jersey line.

Of bog iron ore, specimens of various sizes may be obtained in the towns of Blooming-Grove and Monroe.

Putnam County. A bed of limonite, containing some oxide of manganese, occurs very near the line between Philipstown and Carmel, in Peekskill Hollow, about ten miles northeast of Peekskill village. Its extent is not known, but great quantities of ore have been raised from it. It seems, however, to be too largely mixed with earthy matters to yield good results in smelting.

Dutchess County. Extensive and most valuable deposits of brown hematite occur in various parts of this county. They have been long and profitably wrought, and the quantity of ore seems to be inexhaustible. The first of these deposits that I shall notice, is the

Fishkill Bed, situated in the town of Fishkill, about three miles northeast of the village of Hopewell. It occurs in a hill, the surface of which is made up of a very coarse gravel, imperfectly cemented with clay and loam.

The ore, which is chiefly limonite, presents almost all the varieties from the compact brown hematite to the yellowish clayey ochre, which in its moist state forms a cement for the more compact masses. The brown ore is usually in the form of rounded nodules, which are sometimes hollow; and when this is the case, the inner surface is highly polished, and has the appearance of having undergone fusion. Not unfrequently beautiful stalactites of various forms and sizes are found in these balls, and, occasionally, there is observed a very thin lining of a black powder, which is believed to be oxide of manganese. These stalactites exhibit fibres radiating from the centre in the most distinct and beautiful manner.

According to the observations of Mr. Mather, this, as well as the other beds of limonite found in this part of the county, is situated at the junction of mica or talcose slate with the grey and white limestone.†

Clove Ore Bed. This is an extensive deposit of brown hematite, situated in the south-western part of the town of Union-Vale. The general appearance of the hill or mound in which it occurs, does not differ much from that of the preceding; the bed, however, seems

* Horton. *New-York Geological Reports,* 1839.

† *New-York Geological Reports,* 1838.

to be more extensive, at least it has been more extensively worked. This, like most of the other ore beds in this district, is worked *to the day*, as it is technically called; excavations being made in various places from the surface of the ground, and the ore thus exposed, and subsequently removed.

In its mineralogical characters, this ore is quite similar to that found in the Fishkill bed; but perhaps there is a larger proportion of the *ochrey* or *fine* ore, as it is here called, which is usually considered more valuable than the other varieties. Associated with this ore there is occasionally found a bluish mass resembling specular oxide of iron, but which, upon examination, is ascertained to consist of minute crystals of oxide of manganese with a high metallic lustre. This locality is further deserving the notice of the mineralogist, from the fact that the rare mineral gibbsite is associated with the hematite. Previously to my announcing its occurrence here in 1837, it had only been found at Richmond in Massachusetts.

The following is the composition of a specimen of hematite from the Clove mine:

Peroxide of iron,	80.27
Insoluble matters,	7.43
Water,	11.66

Foss Ore Bed. Proceeding from the Clove bed in a northwestern direction, after crossing Chesnut ridge, we come to a deposit of ore known by the above name. It is situated in the town of Dover, about a mile and a half west-southwest from the furnace of the Dover Iron Company. This bed is found in a valley between two spurs of the mountain which passes through this part of the county; and it is particularly interesting as showing the association of the hematite with the mica slate, which occurs here in strata of some thickness, and contains garnets of various sizes and forms. In extent, however, this bed appears to be inferior to either of those already noticed. The ore also is in much larger masses, does not exhibit those beautiful imitative forms, and is not only with more difficulty reduced to powder, but contains a larger proportion of foreign substances.

Amenia Ore Bed. This is found near Ameniaville, in the northwestern part of the town of Amenia. This is an enormous deposit of hematitic iron ore, from which supplies are constantly obtained for several furnaces in the vicinity. The bed has been opened at various places for the distance of an hundred yards, and the ore presents all the varieties observed at the other localities, and at the celebrated Salisbury Mine in Connecticut. It often occurs in the form of stalactites of various sizes, and possessing uncommon beauty. The same high polish, or blackish sooty matter, is observed on the inner surface of the nodules; and they not unfrequently have a light brown colour, and a structure so distinctly fibrous as to give them a considerable resemblance to wood. There is also intermixed with the nodules of the brown ore, a fair proportion of the yellow pulverulent ochre which is usually so much esteemed by iron smelters.

A fragment of a beautifully radiated stalactite from this locality had a specific gravity of 3.828; and upon calcination, lost 13.5 per cent of its weight. It is probably a specimen of one of the purest varieties of this ore. Its composition was ascertained to be as follows:

Peroxide of iron,	82.90
Silica and alumina,	3.60
Water,	13.50
Oxide of manganese,	traces.

This bed is said to furnish five thousand tons of ore per annum, the average yield of which is fifty per cent of pig iron. The amount of ore is supposed to be inexhaustible.

There are several beds of the same ore, but of inferior importance, in the vicinity of that just noticed. Such as the *Chalk Pond* and the *Indian Pond ore beds*, the former of which is about two and a half miles northeast of Ameniaville, and the latter, on or near the Connecticut line between Salisbury and Sharon. There is also another bed at Squabble Hole, about two miles south-southwest of Ameniaville, which may prove to be a continuation of the Amenia bed. At each of these localities, ore of good quality, and in considerable quantity, has been obtained.

The iron region which has just been described, is undoubtedly a part of the great series of deposits which has, with little interruption, been traced in a nearly northern direction through the States of Connecticut, Massachusetts and Vermont. Thus the ore is known to occur at Kent and Salisbury in Connecticut, at Lenox and Richmond in Massachusetts, and at Bennington, Pittsford and Monkton in Vermont. At many of these localities it is accompanied by an ore of zinc, although in proportions too small to be detected by ordinary analysis; and in Vermont, it is associated with the oxide of manganese. At the Ancram furnace in Columbia county, where the Salisbury ore is used, layers of oxide of zinc are formed in the chimney; and the same thing has been observed at some of the furnaces in Dutchess county, proving that this mineral also exists in the ores there found. A specimen of this substance which I obtained at Ancram,* made up of several distinct layers of a yellowish colour, gave upon analysis the following results in 100 parts, viz:

Oxide of zinc,	96.10
Oxide of iron,	2.90
Carbon,	1.00

Bog iron ore has been found in various parts of this county, but not of such a quality or in such quantity as to be of any value.

Columbia County. Few important beds of iron ore are at present known to exist in this county. The following deserve to be noticed.

Prescott's Ore Bed. This is situated in the town of Hillsdale, one and a half mile north of the Columbia turnpike. The ore is hematite in detached nodules, alternating with ochre and fragments of decomposed slate rock. It has been used chiefly for the manufacture of yellow

* This substance is known by the name of *Cadmium* or *Cadmia*. The oxide of zinc contained in these ores of iron is volatilized by the heat, and is again deposited in the chimney of the furnace. Several analyses will be found in Dumas, *Chimie appliquée aux Arts*, III. 197.

ochre by Mr. C. Prescott, who also opened another bed about three quarters of a mile south of the former, and which has since been worked by an iron company in Salisbury, Connecticut.*

Copake Ore Bed. This is situated about two miles northeast of Copake Flats. Although not extensively worked, the ore is thought to be abundant.

In addition to these beds of hematitic ore, Mr. Mather has noticed, in the Report just quoted, several localities of bog iron ore. One is in the valley of Kline Kill, three or four miles east of Kinderhook, and is thought to be extensive. Others less important are noticed in the towns of Claverack, Beekman and Austerlitz.

Limonite, principally in the form of bog ore, has been found in small quantities in the counties of Ulster, Sullivan, Delaware, Broome, Tioga, Otsego and Cattaraugus; but I am not aware that in any of them it is in sufficient abundance to warrant the expectation that it will be of any value in the manufacture of iron.

Albany and Saratoga Counties. Bog iron ore occurs in various parts of these counties. It is here, as elsewhere, usually found in swampy or marshy ground, and affords a fine illustration of those chemical operations which are continually going on in nature; as the ore is evidently deposited from water, which, by its excess of carbonic acid, originally held the oxide of iron in solution. From Albany county a considerable quantity of this ore has been obtained, and its principal use has been to mix with the magnetic oxide, by which means the quality of the resulting iron is said to be much improved.

Washington County. Brown hematite has been found in various parts of this county, and some of the beds are of considerable value. At the head of South Bay is an abundant deposit, and there is also an extensive locality of the same variety about two miles southeast of the village of Whitehall. The specimens of this ore which I have seen, are generally similar to many of those found at the beds in Dutchess county.

Essex and Clinton Counties. There are but few localities of limonite in these counties. A small and probably quite unimportant bed of the bog ore occurs about a mile north of Port Henry in Essex, and the same variety is said to be abundant on the head waters of the Saranac in Clinton county.

Franklin County. Bog iron ore is found at Malone and several other places. It is only at Westville, however, that it is found in sufficient abundance to be used in the process of reduction.

St. Lawrence County. There is scarcely a town in this county in which bog iron ore does not occur in beds of greater or less extent. Dr. Emmons advances the idea that all the deposits of this kind found here have been produced by the decomposition of pyritous iron, and the oxides intermixed with it. "This is the case certainly," he says, "with some of the larger collections, as their formation can be traced directly to the parent rock, in which the iron pyrites is largely disseminated, and which is also undergoing constant decomposition."†

* Mather. *New-York Geological Reports*, 1838.

† *New-York Geological Reports*, 1838.

One of the largest collections of this kind is on the lands of Dr. Thatcher and Mr. Kent, in the town of Hermon. The quantity at this bed is supposed to be inexhaustible; but in consequence of the admixture of iron pyrites, it becomes necessary to submit the ore to the process of roasting, or long exposure to the atmosphere.

In the town of Fowler there is a bed of the same variety of ore, which has long supplied the Fullerville furnace.

There are deposits of this ore in the towns of Fowler and Gouverneur, in which are distinctly observable twigs, roots and leaves of the birch and beech, the vegetable matter of which is entirely replaced by the ferruginous oxide; the process being probably analogous to that by which the substance of leaves, &c. is replaced by carbonate of lime, in what is commonly called the process of petrifaction.

Bog ore is not unfrequently met with in the town of Canton, but the quantity has heretofore proved insufficient for use. This remark also applies to the town of De Kalb.

The bed from which the Waddington furnace is supplied, is situated near the River La Grasse, about two and a half miles from the village of Columbia, and about seven miles from the village of Waddington. There are three varieties of ore, differing very little in their composition. One consists of large lumps, and is known by the name of *pan ore;* another, in small masses more or less rounded, is called *shot ore;* and lastly, the ochrey ore, called also *loam ore.* All these varieties have a reddish yellow colour when reduced to powder, and, by calcination, lose from 18 to 20.5 per cent of their weight. After this operation they become black, and are freely taken up by the magnet; although before they are subjected to heat, they are not in the slightest degree influenced by it. A specimen of this ore gave, on analysis, the following results, viz:

Peroxide of iron,	71.00
Silica and alumina,	8.50
Water,	20.50

The extent of this bed has never been fully ascertained, but it is supposed to be sufficient to supply the furnace fifteen or twenty years.

Another valuable bed of the same ore has been found near the boundary of the towns of Madrid and Louisville; and still another, said to be of great extent, is situated on the Deer river in the town of Brasher. The variety called pan ore predominates, and it is of an excellent quality.*

Jefferson County. Near Carthage, in this county, there is a bed of bog iron ore, which has been worked for several years, but it does not yield a very abundant supply. There is also a deposit of this ore in the vicinity of the village of Oxbow, which resembles some of those occurring in St. Lawrence, in containing stems, roots and leaves, which have undergone the process of conversion into oxide of iron.

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* For this and the preceding notices, I am indebted to William Ogden, Esq. of Waddington.

In the Counties of Madison, Onondaga, and in some of the still more western ones, there not unfrequently occur deposits, to which Mr. Vanuxem has given the name of *Tufaceous Iron Ore*, being a mixture of calcareous tufa and hydrate of iron. Among other localities, may be noticed one a mile west of Chittenango in Madison county; another, two and a half miles northeast of Salina in Onondaga; and another on Nine-mile creek, between Marcellus and the great embankment of the Syracuse and Auburn railroad.

The proportion of oxide of iron in this compound is usually small. With the magnetic oxide, it would be valuable as a flux; but it so happens that the abundant iron ore of Western New-York, (the lenticular clay iron ore,) is itself largely mixed with carbonate of lime.

TABLE

Exhibiting the composition of several Iron Ores found in the State of New-York, and the proportion of Metallic Iron which they contain, in 100 parts.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Protoxide of iron,	25.40	96.50	44.10	95.75	98.90	89.00	94.84	42.26
Peroxide of iron,	70.50		52.75					53.69
Oxide of manganese,	1.60		traces.					
Silica,	and loss, 2.50	3.50	3.15	4.25	1.10	11.00	and titanic acid. 5.16	4.05
Alumina,								
Titanic acid,			traces.					
Metallic iron,	69.10	71.11	71.22	70.55	72.86	65.57	69.88	70.13

	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.
Protoxide of iron,	70.80	92.97	24.50	92.15	27.00			
Peroxide of iron,			66.80		71.50	98.00	97.00	96.52
Oxide of manganese,							traces.	
Silica,	and loss, 1.20	5.93	8.70	and other insol. mat 7.85	and loss, 1.50	2.33	2.83	3.48
Alumina,								
Titanic acid,								
Carbonate of lime,	25.00							
Plumbago,	3.00							
Lime,						traces.	traces.	
Metallic iron,	52.16	68.50	65.81	67.89	71.00	68.60	67.90	67.56

	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.
Peroxide of iron,	96.00	51.50	42.93	72.37	80.27	82.90	71.00	68.00
Oxide of manganese,						traces.		8.50
Silica,	4.00	6.00	17.99	15.43	7.43	3.60	8.50	6.50
Alumina,		7.50						
Carbonate of lime,		24.50	28.33					
Carbonate of magnesia,		7.75	10.40					
Water,		and loss, 2.75		12.20	11.66	13.50	20.50	17.00
Metallic iron,	67.20	36.05	30.05	50.65	56.18	58.03	49.70	47.60

No. I. Magnetic oxide of iron. Long Mine, Monroe, Orange county. Page 7.
II. Magnetic oxide of iron. Rich Iron Mine, Monroe, Orange county. Page 8.
III. Magnetic oxide of iron. Forshee Mine, Monroe, Orange county. Page 8.
IV. Magnetic oxide of iron. O'Niel Mine, Monroe, Orange county. Page 9.
V. Magnetic oxide of iron. Wilks Mine, Monroe, Orange county. Page 9.
VI. Magnetic oxide of iron. Denny Mine, Philipstown, Putnam county. Page 11.
VII. Iron sand. Banks of Moose river, Lyondale, Lewis county. Page 13.
VIII. Magnetic oxide of iron. Fort-Ann, Washington county. Page 13.
IX. Magnetic oxide of iron. Warrensburgh, Warren county. Page 13.
X. Magnetic oxide of iron. Penfield Mine, Crown-Point, Essex county. Page 14.
XI. Magnetic oxide of iron. Crag Harbour, Essex County. Page 15.
XII. Magnetic oxide of iron. Newcomb, Essex county. Page 17.
XIII. Magnetic oxide of iron. Arnold Mine, Clinton county. Page 18.
XIV. Light blue ore. Arnold Mine, Clinton county. Page 18.
XV. Grey ore. Arnold Mine, Clinton county. Page 18.
XVI. Specular oxide of iron. Kearney Ore Bed, St. Lawrence county. Page 25.
XVII. Specular oxide of iron. Pierrepont, St. Lawrence county. Page 26.
XVIII. Lenticular clay iron ore. Wolcott, Wayne county. Page 28.
XIX. Lenticular clay iron ore. Lower Genesee Falls, near Rochester, Monroe county. Page 28.
XX. Limonite. Southfield, Richmond County. Page 30.
XXI. Hematite. Clove Ore Bed, Union Vale, Dutchess county. Page 32.
XXII. Hematite. Amenia Ore Bed, Amenia, Dutchess county. Page 33.
XXIII. Bog iron ore. St. Lawrence county. Page 34.
XXIV. Brown iron ore, or umber. Forshee Mine, Monroe, Orange county. Page 8.

Present Condition of the Manufacture of Iron in the State of New-York.

The manufacture of iron was commenced, in the State of New-York, at a comparatively early period. It was actively carried on in Orange county for several years previously to the American Revolution. I have, however, no means of determining the extent of the manufacture at that early date. In 1810, the value of the iron manufactured in the State was estimated at $859,895. At that time there were in the counties of Essex and Clinton, one bloomery and twelve forges, at which 259 tons were manufactured, besides 100 tons from the furnaces.* In 1830, the number of iron works and trip hammers in the State was 335, of which the Fourth and Fifth Senate Districts contained no less than 176. According to the census returns made in 1835, the number of iron works and trip hammers was 434, and the value of the iron manufactured was $4,713,530; being an increase from 1830 of nearly 100 iron works and trip hammers, and in the value of iron manufactured of upwards of $1,000,000. In 1840, according to the census returns, there were 306 furnaces, bloomeries, forges and rolling mills; in which 82,654 tons of cast iron, and 58,275 tons of bar iron, were manufactured. The capital invested in these was estimated at $2,113,818. To this should be added $1,806,638, as the value of hardware, cutlery, &c. manufactured.

If these statements are to be relied on, the manufacture of this important article did not advance in the State of New-York during the period from 1835 to 1840.

The prosperity of the manufacture of iron in any country must depend mainly upon the abundance of the raw material, and the low price at which it can be obtained. It is essential also to its success, that the iron produced be of good quality.

From the account which has been presented of the iron ores found in this State, it is evident that there is a supply for the utmost demand. There is, however, a considerable difference in the quality of these ores; or, what amounts to the same thing, manufacturers give a decided preference to those from particular localities, which thus have a greatly increased value, while others have been in a measure neglected, or at least are considered of little importance. Making every allowance for the natural superiority of some ores, this result may in part be ascribed to the want of skill in conducting the mining operations, and in following out the details of the manufacture.

In regard to the first of these points, it may be remarked, that the raising of the ores has heretofore been generally conducted in the rudest and most careless manner. With a few exceptions, the whole object of the proprietors of our mines seems to have been to obtain a *present* supply of ore at the easiest and cheapest rate. Hence excavations have often been improperly made, and good beds of ore have not unfrequently been rendered valueless by the falling in of rocks, or by vast collections of rubbish which have accumulated. The consequence of these injudicious, and in some instances ruinous operations, the result oftentimes of false notions of economy, has been to render this branch of mining a peculiarly expensive

* Tench Coxe. *Statement of Arts and Manufactures in the United States.*

and precarious employment. This of course must have an effect upon the manufacturer; and it is not too much to say, that until this business is conducted with that science and skill which are brought to bear upon it in other countries, there will be wanting in our case one important element of success.

A review of the processes of manufacture pursued in some parts of the State will, I think, afford another clue to the causes which have served to depress this branch of industry; and as this is one of the most important topics connected with the practical part of this investigation, I trust that I shall be excused for entering somewhat in detail.

In the description of the ores of iron which I have already given, it will be observed that some of them are nearly pure; that is, consist almost entirely of iron and oxygen in variable proportions. Such are many of the ores found in the northern counties, in Orange county, &c. As it is only necessary, in order to convert these pure minerals into metallic iron, that they should be deprived of the oxygen which they contain, the reduction may be effected in a very simple manner. They are accordingly often mixed with a proper proportion of charcoal, and subjected to heat in a low or *Catalan forge*. A part of the carbon, combining with the oxygen of the ore, passes off in the form of carbonic acid gas; while a variable proportion of the carbon also combines with the iron, and causes the formation of cast iron, steel, or malleable iron, according to circumstances. If the application of the heat be discontinued after the first reduction of the ore, the result will be cast iron; but as the object in this case is usually to obtain malleable iron by a single process, charcoal is added, and the heat continued until the cast iron loses its liquidity, and is converted into a *loup*, as it is termed; after which it is brought under heavy hammers, and formed into bars of various sizes and forms. When a peculiar ore, as the spathic iron, is employed, the product of this process is an inferior kind of steel.

This forge is the most humble, and probably the oldest workshop of iron, and was formerly in general use where the ores were sufficiently pure to admit of its employment. As it could be erected at a trifling expense, it enabled the small capitalist to prosecute the manufacture in situations where fuel was abundant, and it often employed the farmer in the intervals of agricultural labor. These are perhaps the principal reasons why the forge is so generally used in the northern part of the State. But I think it may be safely affirmed that its employment is wasteful; and as fuel becomes less abundant, and capital increases, it must give place to the improved furnace.*

It is evident from the description of the process which has just been given, that the conversion of the cast iron into malleable iron in the open forge, takes place during the free exposure of the former to heat and air in contact with the combustible. There must, however, be great waste both of fuel and of ore. Facts prove the correctness of this assertion. If I have been correctly informed, three tons of the best ore, such as that from the Arnold mine, are required for producing one ton of malleable iron; and five hours is the average time consumed in carry-

* See Col. Gibbs' Observations on the Iron Works at Vergennes, Vermont. *Bruce's American Mineralogical Journal*, p. 80.

ing the ore to the state of rough bar, one hundred and fifty pounds being the usual weight of the *loup*. Now analysis shows that the Arnold ore contains from sixty-eight to seventy-one per cent of metallic iron; and although great allowance is to be made for the waste necessarily attendant upon metallurgic processes, we may fairly conclude that when it amounts, as it does in the present case, to a hundred per cent, there must be some defect in the process of reduction.

The clay iron-stone so extensively used in Great Britain, seldom contains more than thirty-five per cent of metallic iron; and yet it is stated that three tons of this ore yield about one ton of cast iron, and this last again loses about ten or twelve per cent of its weight by conversion into refined iron, so that about three and a half tons of the ore yield a ton of refined iron. The difference will be more apparent from the following statement.

Three tons of Arnold ore, at 70 per cent, ...	=	4,704 lbs. metallic iron.
Three and a half tons clay iron-stone, at 35 per cent,....	=	2,744 " do. do.
Difference,.....		1,960 lbs.

Showing that, by the process of which we are now speaking, for every ton of rough bar iron obtained, there is a waste of nearly another ton of metallic iron. And in this estimate, nothing has been allowed for the loss which these bars suffer in the various operations to which they are subjected previously to their preparation for the manufacture of nails, &c.

The important influence which the facts just stated must exert upon the manufacture of iron in the district where this process is almost exclusively employed, can scarcely be doubted, when it is stated that the price of ore is sometimes not less than five dollars the ton. To all this should be added the waste of fuel, which I am satisfied may be fairly set down to this mode of manufacture.

Another, and perhaps more serious objection to the process under examination, is the want of uniformity in the texture of the iron, and its unfitness for many uses to which this metal is applied. This is owing to the alternate mixture of steely grains with those of the malleable iron, a result which no care can prevent. Hence chain cables manufactured from this kind of iron, although they are sufficiently tough in some parts, in others have a tenacity so inconsidcrable as to be casily destroyed by the weight applied to them. To the same want of uniformity in the texture, is to be ascribed the rapidity with which they are oxidated by exposurc to the atmospherc.

In advcrting to these facts, I trust that I shall not be accused of a want of interest in our manufactures. They arc, it is believed, well known to most of our iron masters; and my objcct in thus noticing them, is to urge the importance of the introduction of a less cxceptionable process than that which has just been described. The iron ores in various parts of the Statc will not suffer in the comparison with any in the world; and there is no reason, if proper attention be paid to the manufacture, why the iron obtained from them should not be as valuable as any other.

The Dannemora iron ore, from which the most celebrated Swedish iron is obtained, is similar

in its characters to the primitive or magnetic ores found in the northern and southern parts of the State. It sometimes, however, contains, as we are informed by Dr. Thomson, a portion of carbonate of lime, and is also associated with quartz and with hornblende. In the process of reduction, the ore is broken into small pieces, roasted, and then put into conical shaped furnaces constructed of the slag from cast iron, which is found to answer the purpose fully as well as bricks, and to come much cheaper. In these furnaces, it is mixed with the requisite quantity of charcoal; but the addition of limestone is seldom necessary, because it exists already in the ore. Here it is melted and separated from the slag, which is allowed to run off, or is cast into bricks, according as it is wanted. The cast iron obtained by this process is as white as silver, very hard and brittle, and is not liable to rust; but in this state it cannot be applied to any useful purpose, in consequence of its brittleness. This iron is converted into malleable iron by heating it in a bed of charcoal and oxide of iron, and hammering it out into bars while hot. In this state it is whiter than common iron, of a distinctly fibrous texture, and is much stouter than any other species of iron whatever.*

There is still some uncertainty in regard to the cause of the superiority of the Dannemora iron. By some it is ascribed to the presence of manganese. Berzelius supposes it due to the presence of the metallic basis of silica; another author, again, refers the superiority to the mixture of carbonate of lime which the ore contains; and finally, it has been ascribed principally to the process employed; for it is asserted, that by following a similar mode of manufacture, as good iron has been obtained from other Swedish ores as from that of the Dannemora mine.

In those parts of the State where what are called *high furnaces* are in use, the leading principles of the process of smelting are well understood, and in some cases a considerable degree of perfection has been attained. But so many circumstances enter into the iron smelter's manufacture, and an attention to each of them is so important to the success of the whole, that it may be regarded as a striking proof of the ingenuity of our countrymen, that with so few of the necessary data, they have been enabled to prosecute it with even tolerable success. It is now admitted, that in order to carry on this branch of art in the most advantageous manner, it is essential that the chemical composition of the ore should be accurately determined, as well as that of the flux to be used, of the slag or scoria formed during the process, and finally of the iron which is the result. Investigations of this kind have been prosecuted for some years in Sweden, France, Germany and England; and the result has been the introduction of improvements, by means of which the ores have been made to yield a larger quantity and a better quality of iron than was formerly obtained from them.

It has already been stated, that when the ore is of great purity, the process of reduction is exceedingly simple. But as the ores most generally used contain earthy bodies, as silica, alumina, &c. in considerable proportions, the business of the iron smelter consists in fusing the earths, and in deoxidizing the ore by the agency of carbonaceous matter. But silica, when

* Dr. Thomson. *Travels in Sweden.*

subjected to high heat in contact with oxide of iron, unites with it, and forms a silicate which cannot be reduced by carbon. It is, therefore, of great importance to prevent the formation of this compound. One of the means by which this end may be attained, is the roasting of the ore, an operation which is too often neglected by our manufacturers. By being previously roasted, the ore loses its water, if it contains any; the carbonic acid and volatile matters are also driven off, and it is brought to that porous state which permits the flame to come into contact with each of its particles, and thus the metal is reduced before the silicates can be formed. Another advantage gained by the roasting of the ore is, that we avoid in a great measure the evolution of the gases in the furnace, which not only obstruct the free passage of flame, but have a tendency to cool it. It is, therefore, of the greatest importance that particular attention should be paid in all cases to the process of roasting; but especially so, when the more compact kinds of magnetic and specular ores are employed. As the operation is analogous to the burning of limestone, it may be performed either in the open air, or in furnaces constructed for the purpose, as may be found most convenient and economical.*

In most cases, however, the roasting is not sufficient to effect the complete separation of the matters which prevent or retard the reduction of the metal. In order to facilitate the operation, substances are added, which are denominated *fluxes*, the use of which is to bring the earthy matters, mixed or combined with the oxide of iron, to a state of thin fusion or liquidity, so that the particles of metallic iron, having been formed by the action of the carbon, may run together and fall down to the bottom of the furnace. It is evident, therefore, that the nature of the flux must differ with that of the ore. When siliceous matter predominates, limestone is used, so that the silica may form with it a fusible compound, and thus liberate the metal. On the contrary, when an ore contains carbonate of lime, this substance being also infusible, a siliceous flux is then to be employed.

From this view of the nature and use of fluxes, it is apparent that they cannot be employed in an arbitrary or empirical manner. The particular kind, as well as the proportion, must be determined by the chemical composition of the ore; and it is very seldom that two ores so closely resemble each other as to allow the use of exactly the same flux.

With the exception of the lenticular argillaceous oxide of the western part of the State, and the magnetic iron from Warrensburgh, all the ores which I have examined are siliceous or aluminous, and require for their reduction a flux composed chiefly of carbonate of lime. Limestones well adapted to this use, abound in various parts of the State.

That the proper adjustment of the flux to the nature of the ore is a subject not yet sufficiently attended to by our iron smelters, I think is evident, from an examination of the scoriæ of many of our furnaces. Small globules or buttons of nearly pure iron, or of the metal slightly oxidated, are sometimes found in the hard and glassy compound, and by treating this refuse with additional portions of flux, a large proportion of metallic iron is obtained. I was informed by the conductor of a furnace in Dutchess county, that a heap of this slag, which

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* For descriptions of processes and apparatus, *see* DUMAS, *Traité de Chimie appliquée aux Arts*, IV. 619.

he had considered as without value, and which he intended to have removed from his premises at some expense, had been found to be worth more than $3,000, for the iron which it contained.

I have already observed, that the nature and proportion of the flux most proper to be employed in any given case, cannot be positively determined without an analysis of the ore. Berthier gives some general directions on this subject, which it may be useful to introduce in this place; and especially so, as his statements are the result of an extensive series of experiments. According to this chemist, the proportion of flux to the ore necessary to ensure the requisite degree of fusibility should be such, as that the compound may contain from 45 to 60 per cent of silica, 20 to 35 per cent of lime, and 12 to 25 per cent of other earths. The nature of the latter has a great influence upon the fusibility of the scoria. Alumina is the least fusible, and it should not much exceed the proportion of 0.15. Magnesia is much more fusible, and it may attain the proportion of 0.25 without inconvenience. But when other metallic compounds form part of the ore, as manganese, titanium, phosphate of iron and of lime, the arseniates of iron, iron pyrites, galena, blende and chromium, the proportion of fluxing materials must be determined by their nature, and by the proportions in which they exist in the ore.*

In regard to fuel, and its mode of employment, there is also room for improvement in our manufactories. Charcoal, the combustible almost exclusively employed at present, no doubt possesses great advantages; but the want of due attention to the process of carbonization, renders this substance of very variable purity. This not only increases the expense, but causes a variation in the degree of heat quite unfavourable to the success of the iron smelter's operations. In those cases, by no means unfrequent, where the proprietors of iron works have also under their control the manufacture of charcoal intended for their use, it would be greatly to their advantage to introduce some of those improvements which have been adopted in England and France, and the value of which experience has fully confirmed.

Although charcoal is perhaps the best fuel for the iron furnace, it is well known that causes are gradually, though constantly, operating to diminish the supply, and of course to increase its price. In some cases this already begins to act as a damper upon the manufacture in question. The same difficulty was experienced in England at a very early period, when it was fortunately ascertained that the bituminous coal, which abounds in that country, when converted into coke, might be substituted in the place of charcoal. And it is to this discovery that England is chiefly indebted for the commanding position which she now occupies as a manufacturing nation. In this country, various attempts have been made to substitute anthracite for charcoal, in iron smelting; which at length, by the employment of the hot blast, have been crowned with complete success. This great improvement in the manufacture of iron, however, will be of more value in those States where anthracite is found, than in our own; but it cannot fail, even here, to be highly beneficial.†

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* *Traité des Essais par la Voie Sèche*, II. 339.

† I have just received a small work, entitled "*Notes on the use of Anthracite in the Manufacture of Iron*," by Prof. WALTER R. JOHNSON; to which I would refer those who are interested in this subject.

ORES OF LEAD, ZINC AND COPPER.

Although these ores have been for a long time known to occur in various parts of this State, they have, for a few years past, in some counties at least, been objects of peculiar interest. It has, indeed, been supposed, that lead, zinc, and perhaps copper, would be ranked among our most important mineral productions. Whether these anticipations are well founded, will probably appear from the facts about to be presented.

SULPHURET OF LEAD, OR GALENA. *Cleaveland.*

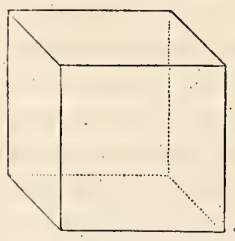
Plomb sulfuré. *Hauy.* — Hexahedral Galena, or Lead-glance. *Jameson.* — Hexaedrischer Bleiglanz. *Mohs.* — Galène. *Beudant.*

DESCRIPTION. This mineral, which, here as in other parts of the world, is the common ore of lead, has a bluish grey colour, usually called lead-grey; streak unaltered. The colour is liable to tarnish, and the mineral then becomes iridescent.

It occurs massive and crystallized. When massive, it is granular or compact, and sometimes striated or fibrous. When crystallized, it is foliated, and has a threefold cleavage parallel to the faces of the cube, which is the primary form. Sometimes the cube is truncated on its angles and edges, and sometimes it is elongated. It occurs also in octahedrons, cubo-octahedrons, &c.

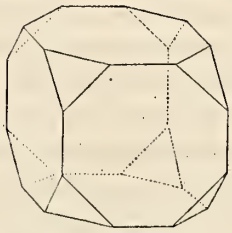
The following crystalline forms have been observed in this State:

Fig. 7.



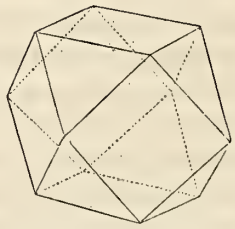
Rossie, St. Lawrence Co.
Martinsburgh, Lewis Co.

Fig. 8.



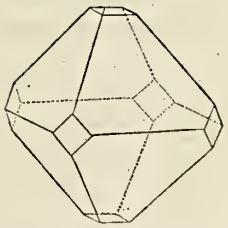
Rossie, St. Lawrence Co.

Fig. 9.



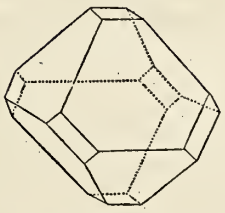
Rossie, St. Lawrence Co.

Fig. 10.



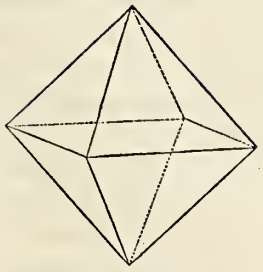
Morristown, St. Lawrence Co.
Martinsburgh, Lewis Co.

Fig. 11.



Martinsburgh, Lewis Co.

Fig. 12.



Morristown, St. Lawrence Co.
Martinsburgh, Lewis Co.
Wurtzboro', Sullivan Co.

Lustre splendent to glimmering, and metallic; sectile; very easily frangible.

Hardness 2.5 to 3. Specific gravity 7.532 to 7.652 (*Thomson*); 7.759 (*Beudant*).

Fusible before the blowpipe, with the disengagement of fumes of sulphur. When heated on charcoal, the metallic lead is obtained.

Soluble in nitric acid, forming a white precipitate of sulphate of lead. When dissolved in dilute nitric acid, with only a slight elevation of temperature, the solution produces a precipitate of brilliant blades of metallic lead upon a clean plate of zinc; but not upon a plate of copper, unless it contains sulphuret of silver.

Distinctive characters. From graphite and sulphuret of molybdenum it may be distinguished by its greater specific gravity; while from sulphuret of zinc, which it sometimes resembles, its metallic and shining streak will be sufficient to distinguish it.

Composition. The constituents of this mineral when pure, are sulphur 13.34, lead 86.66, in 100 parts; but it sometimes contains minute proportions of silver, antimony and iron.

This mineral is found in various parts of the State, and sometimes in large quantities. The localities will be noticed in the alphabetical order of the counties in which they occur.

Columbia County. At the *Ancram Lead Mine*, as it is usually called, about four miles southeast of the Ancram furnace, galena is found in a hill composed of slate and limestone. Two or three veins may here be observed on the surface; which, with their gangue, vary in width from a foot to three or four feet. When they widen, as they sometimes do, the ore is very sparingly disseminated in the calcareous spar and quartz, which constitute its principal associates. The galena at this locality does not seem to form a true vein, but to be a collection of strings communicating with masses or beds of various dimensions. These strings are parallel with the strata, and not at right angles to them, and the ore is not bounded by a regular wall, but gradually loses itself in the accompanying rock.

The galena is both foliated and granular, but no regular crystalline forms have been observed. It is associated with blende and copper pyrites in a gangue of quartz; calcareous spar and sulphate of barytes are also occasionally intermixed. It is owing to these foreign minerals, that some difficulties have been encountered in the separation and reduction of the lead.

The following are the results of the analyses of two of the best specimens of galena obtained from this locality, viz:

	I.	II.
Sulphur,	13.00	12.68
Lead,	83.65	81.61
Silica, or quartz,	3.50	5.71
Carbonate of lime,	traces.	

But it is difficult to obtain any quantity of lead ore without an admixture of the sulphurets of zinc and copper, and the other associated minerals. In addition to these, it may be remarked, that there is also a minute proportion of sulphuret of silver mixed with the ore. This, however, is scarcely deserving of notice in an economical point of view, as the expense of separating the precious metal would probably exceed the value of the product.

This mine has been extensively worked at various times, and the visitor will find shafts and adits of great depth and length, and the proofs of large expenditures. Unfortunately, the expectations of those who were engaged in these operations have not been realized; and I am constrained to add, that there is nothing at this locality which would warrant any additional outlay.

Several other localities of galena, although of less importance than that just noticed, occur in other parts of this county. In the town of Canaan, veins of lead ore have been found, one or two miles south of Whiting's pond. The ore is fine grained, and is mixed with yellow blende, and with black and yellow copper. There is also a similar vein in the town of Claverack, and the same mineral has been found in several places in New-Lebanon.*

Dutchess County. There is a thin vein of galena in the southwest corner of the town of Northeast, which is probably a continuation of some of those noticed in the county of Columbia. On the farms of Judge Bockee and Mr. W. Bryan, are several openings, from which considerable quantities of ore have been obtained. These mines are said to have been worked as early as the year 1740, by a company of Germans, and the ore sent to Bristol, England. They were, however, soon abandoned, but were re-opened during the revolution, when a few tons of lead were again obtained. Since that time they have been entirely neglected.

Excavations are to be seen on the lands of Judge Bockee, at short intervals for half a mile, showing numerous small veins of galena, associated with the sulphurets and carbonates of

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* Mather. *New-York Geological Reports*, 1838.

copper. Mr. Mather states, that all the openings are in the limestone, (which is of a bluish-grey colour, and nearly compact structure,) a few rods east of its junction with the slate on the west. From the great number of small veins in this vicinity, he thinks it probable that larger ones occur, of which these are the mere strings.*

Unimportant localities of sulphuret of lead have also been noticed in the towns of Amenia and Rhinebeck.

Herkimer County. From the specimens of galena which have been found in this county, it was supposed by some that workable beds of it would be discovered. Thus far, however, these anticipations have not been realized. Excavations have been made about two miles from Salisbury Corners, but they have furnished only cabinet specimens of the sulphurets of lead, iron, zinc and copper, with occasional stains of the green carbonate of copper and bog iron ore; the former, proceeding from the action of the atmosphere upon pyritous copper; and the latter, from the decomposition of iron pyrites.

Small quantities of lead ore have been found in Jefferson County, but its occurrence has not yet led to many extensive mining operations.

Lewis County. Near the village of Martinsburgh, galena is found associated with iron pyrites in narrow veins, traversing the Trenton limestone. At one of these, about three thousand dollars have been expended in excavations, which extend for nearly two hundred feet along the surface, and at one point are fifty feet in depth. Copper pyrites and blende are sometimes associated with the galena. The gangue is calcareous spar, which often exhibits interesting crystalline forms. Some of the specimens of galena have a beautiful feathery appearance, resembling certain ores of silver.

A specimen of the galena from this locality gave the following results, viz:

Sulphur,	11.97
Lead,	77.15
Iron pyrites, carbonate of lime, &c.	10.88

The same minerals are found in minute quantities on the banks of Whetstone creek, a mile and a half from Martinsburgh. The galena at this locality is often in small but perfect octahedrons. The associated calcareous spar has the form of lenticular crystals.

At the falls near Lowville in this county, galena has been found with cubes of green fluor and six-sided crystals of calcareous spar. This ore was erroneously thought to contain a large proportion of silver, and the locality is often called the "Silver Mine."

Monroe County. Small masses of galena occur in the limestone near Rochester in this county, and at one locality a small vein has been noticed. A company was some time since formed for mining and working this ore; but it is almost unnecessary to add, that it has never commenced active operations.

* *New-York Geological Reports*, 1838.

Montgomery County. Lead ore occurs in this county, but none of the localities seem to be of much importance. On Flat creek in the town of Root, about a mile and a half south-east of Spraker's Basin, are several small veins of iron pyrites, galena and blende, in a matrix of calcareous spar, the whole being in a fissile slate rock. A small outlay has been incurred here, which has been sufficient to exhaust the supply of ore. It is even difficult, at the present time, to obtain good cabinet specimens.

Oneida County. Galena has been found in small quantities in the towns of Vernon and Westmoreland. According to Mr. Vanuxem, this ore, associated with blende, occurs near Hamilton College, in a rock consisting of carbonate of lime and sand.

In Orange County, this mineral has been found near Fallbrook in the town of Deerpark, but in quantities so very small as to deserve only a mere notice. And the latter remark will apply to its occurrence in Rensselaer County.

St. Lawrence County. Valuable deposits of galena have, within a few years, been discovered within this county. On account of their real or fancied importance, and the large expenditures which have been made in working them, it is proper that a detailed description should be here presented.

The first, and perhaps still the most important vein in this county, was opened in the winter of 1835–36. It is commonly known by the name of the *Rossie Lead Mine;* although different parts of the same vein, being owned by different proprietors, usually receive in the vicinity their distinctive appellations. This mine is situated about two and a half miles south of the village of Rossie. The following is a description of it, as it appeared in the early part of August, 1836.

The vein of galena and white decomposed ore was distinctly visible for some distance, passing down a precipitous ledge of primitive rock about fifty feet in height. The average width of the vein was two feet, and it cut the rock in a nearly perpendicular direction; at the lower part, however, inclining slightly to the north. On ascending the ledge, the course and extent of the vein could be easily determined by the excavations which had been made, and by the appearance of the surface in those parts where it had not been opened. Its course was found to be about south-southeast and north-northwest; and its length, as exposed at that time, was about four hundred and fifty feet. And throughout this whole extent, the vein seemed to be so distinctly characterized as to excite surprise that it had not long before been noticed.

About eight feet from the principal vein was a smaller one, which intersected the rock in a direction nearly parallel with the former, and which, at the depth of about thirty feet, united with it.

The galena found in this vein is often crystallized in large cubes, which are not unfrequently modified by truncations upon the angles. A large proportion of the ore, however, is either in foliated masses, which, in consequence of their threefold cleavage, break into cubical or rectangular fragments, or is made up of grains of various sizes. Throughout the whole extent

of the vein, the ore is imbedded in a gangue of carbonate of lime, with druses of calcareous spar of great beauty, and presenting a great variety of crystalline forms. The average width of this gangue is about four feet. As usual, the proportion of the gangue is quite variable, the ore being in some parts nearly pure, and easily separable from the walls; while in others, nearly the whole of the vein is made up of calcareous spar.

The common metallic associates of galena are also found here, viz. iron and copper pyrites and zinc blende, although the latter is of rare occurrence.

Two specimens of galena from this mine were subjected to analysis, with the following results, viz:

	I.	II.
Sulphur,	13.20	13.26
Lead,	85.40	85.35
Carbonate of lime, and loss,	1.40	1.39

No. I. was part of a cubical fragment detached from the gangue. It had a specific gravity of 7.500.

No. II. was of a lighter colour, and somewhat silvery appearance. This peculiarity is probably caused by a tarnish, or perhaps by the contact of the gangue.

This ore also contains a minute proportion of silver, which may be separated by the process of cupellation, but which can hardly be detected by the humid process.

The *lead ashes*, as it is commonly called, found in great abundance on that part of the Rossie vein which was exposed to the atmosphere, and which invested most of the surface specimens of galena, proved to be a mixture of the carbonate and sulphate of lead and carbonate of lime in variable proportions. The formation of this compound was undoubtedly due to the reaction of the carbonate of lime and sulphuret of lead, together with a free exposure to atmospheric influence.

For three or four years, this mine was worked with great activity, and shafts were sunk to the depth of upwards of one hundred and fifty feet. At this depth the vein presented similar appearances to those observed nearer the surface, except perhaps that the proportion of ore to the gangue was somewhat less. Fine druses of crystallized galena and calcareous spar, together with variously modified crystals of iron pyrites and some copper pyrites, were from time to time laid open. A few beautiful specimens of crystallized sulphate of strontian, of a bluish colour, were also found.

Since 1839, however, this mine has not been worked, whether in consequence of the insufficient supply of ore, the expense of raising it, or the large previous outlay, it is unnecessary now to inquire.

A short distance from the preceding, towards the road leading from Rossie to Oxbow in Jefferson county, is the *Jepson vein*, which has a bearing south 88° 30′ east. It has produced a large quantity of ore, and was thought to be little inferior in value to the Rossie vein. Its gangue and associated minerals are also similar.

Two other veins were opened in this vicinity, viz. the *Robinson* and the *Ross veins;* but they have not proved to be of much value.

Some idea of the extent to which the Rossie mines were worked may be inferred from the fact, that the amount of lead produced from them in 1838 was 3,347,463 pounds.*

At Mineral Point on Black lake, six miles below the village of Rossie, is another mining region which promised to be of considerable importance. One vein was opened, which had an average width of two feet; but the ore was largely mixed with the usual gangue, calcareous spar. The general course of the deposit was similar to that of the Rossie vein; but the ore, which was both crystallized and massive, was more largely mixed with sulphuret of zinc.

The mania of speculation which so generally prevailed in 1836 and 37, led to the opening of several other veins in the immediate vicinity. These, however, are at the present time scarcely deserving of notice. In one of them I observed the galena associated with fluor spar, which is not a common occurrence in this region.

In the northern part of the town of Gouverneur is the *Wilson vein,* which in fact is rather a vein of calcareous spar in which are disseminated small masses of galena, than a true vein of lead ore. Some beautiful specimens of crystallized spar have been obtained from this locality.

Veins of galena and calcareous spar, similar in most respects to those already described, have been found in several other parts of this county, viz. in the towns of Fowler and Pitcairn;† but they are at present of no importance, and are not deserving of a detailed description.

Sullivan County. The principal deposit of galena in this county is near the summit of the Shawangunk mountains, about two miles northwest of the village of Wurtzboro', and three quarters of a mile from the Hudson and Delaware canal. The vein or bed is situated in the millstone grit of which this mountain is composed, and which here has a dip west-southwest of about 45°. At the spot where the galena was first observed, a perpendicular shaft was sunk; to intersect which, a tunnel has been excavated, and with this there communicate galleries of several hundred feet in length.

The deposit of ore at this locality is from two to five feet in width, but in this there is a large proportion of quartzose materials. Three varieties of galena are here found, viz. the common, in the form of foliated masses, and breaking into cubical or rectangular fragments; the granular, composed of granular concretions resembling grains of steel; and the compact, made up of very fine grains, and having a compact texture, a somewhat conchoidal fracture, and little metallic lustre.

The galena, in all its varieties, is associated with the sulphurets of zinc, copper and iron; indeed so large is the proportion of the former of these ores, that the vein may with more propriety be called a *zinc*, than a *lead* mine. The galena and blende often appear in the form

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* Report of the St. Lawrence Railroad Committee, 1839.

† Emmons. *New-York Geological Reports*, 1838.

of rounded nodules of various sizes in the quartz, the former being sometimes a central nucleus passing gradually into, and at length entirely surrounded by, the blende.

The difficulties which attend the reduction of the lead ore thus largely mixed with foreign matters, will at once be apparent. Various attempts were made, and large sums expended, by the company, in useless trials to effect the economical separation of these metals. At length, however, this object has been obtained by mechanical contrivances similar to those in use in Germany. At what expense these processes are conducted, and whether they are sufficiently economical to warrant their continuance, I have no means of knowing.

I have only to add, that the mining operations have been carried on in the most judicious manner, all the galleries and levels being susceptible of complete drainage and ventilation. The amount of ore obtained is large, and it is quite probable that it may be increased to any extent, and at a trifling cost. The mineral was reduced in a reverberatory furnace; and the lead, of which many tons have been manufactured, is said to have been of good quality. Both the lead and the ore yield by cupellation a small proportion of silver; too small, however, to warrant the separation in a large way.

The ore itself, aside from the associates above named, is as rich, as valuable, and as easily reduced, as that of any lead mine whatever. The location of this mine too, and the prospect of a supply of ore, are all as favorable as could be desired, while the average quantity of ore in a cubic yard of the vein is as great, if not greater, than that of any lead mine at present known in the State.

The Sullivan and St. Lawrence mines may be thus briefly contrasted. In the latter, the ore is in small veins, with very good associates, and is easily reduced; but the situation of the mines is bad. In the former, the ore is in large veins, with bad associates, and is more difficult of separation and reduction; but the mines are admirably situated, whether we regard the removal of the ore, or the facility of transporting the produce of it.

Ulster County. A mine of galena was opened in this county in 1837, and worked by the North American Coal and Mining Company. It is in the Shawangunk range, about three quarters of a mile from the Red Bridge, which forms the boundary between the counties of Ulster and Sullivan, on the Hudson and Delaware canal. The general character of the deposit of ore is similar to that of the one found in the adjoining county; but the galena has thus far been procured only in very small quantities. It is associated with copper pyrites and sulphuret of zinc. The gangue is quartz, which often occurs in large crystals of great beauty; seldom, however, with double terminations.

This mine was worked by a perpendicular shaft, to which levels, passing into the mountain at different heights, were constructed. There did not seem to me to be any thing here to warrant the expenditure which had been incurred.

The *Ellenville Mine* is about half a mile from the village of that name, at the base of the Shawangunk mountain. The vein is in one of the traverse breaks of the strata, and ranges south 60° east, nearly vertical. The materials which compose it are nearly the same as the grit rock, which it traverses, but more or less loaded with pyrites and crystallized quartz,

and in some places with blende and galena. The vein is from two to three feet wide, and a copious spring flows near its junction with the marsh below. The mine was opened many years since, and has been worked again within a few years, but very little lead ore has been obtained.*

Washington County. Galena was found in the impure limestone in White-Creek, in the year 1823 or 1824. The locality has been examined by Mr. Mather, who represents the ore as lying in small strings and bunches in the rock; and he adds, that the indications on the surface are such as to justify the belief that it will be explored at some future time; but it is doubtful whether it would be a profitable investment of capital. It has the same geological position and relations as the mines in the counties of Columbia and Dutchess, and the ore is said also to contain a small proportion of silver.†

Such are the mines of lead ore at present known in this State. Upon a review of all the information that we possess, truth compels me to say, that the sanguine hopes that a few years since were entertained in regard to them, are far from being realized.

Sulphuret of Zinc, or Blende.

From the preceding account of our lead mines, it will be observed that the sulphuret of zinc is a very common associate of galena; indeed, the latter is seldom found in any considerable quantity without the former. The only ore of zinc heretofore credited to this State, is the sulphuret. This, however, is not found in such quantity as to lead to its use for obtaining the metal. Moreover, this ore is confessedly difficult of reduction, and is not the one from which the metallic zinc is usually obtained. I shall, therefore, reserve the notice of this mineral, and its localities, for the succeeding part of this work.

Sulphuret of Copper, or Copper Pyrites.

The remarks made in regard to the sulphuret of zinc, are generally applicable to this species. It is most usually associated with galena. But it has nowhere been found in sufficient abundance to warrant its introduction into the catalogue of our useful minerals. It will be treated of hereafter.

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* Mather. *New-York Geological Reports*, 1840.

† *New-York Geological Reports*, 1841.

ORES OF MANGANESE.

The most valuable of these ores are the oxides, of which there are several distinct species and varieties. The mineral most abundant in this State, is that which is known by the name of the *Earthy Oxide of Manganese*, or *Wad.*

Description. The colour of this mineral is brownish, or iron-black; it has an earthy appearance, and it is usually mixed with other substances, as silica, alumina, oxide of iron, carbonate of lime, and vegetable matter. It is often friable, easily reducible to powder, and strongly soils the fingers; sometimes, however, it has a fibrous texture, the fibres radiating from a common centre.

It is infusible by the blowpipe, but is converted by it into brownish oxide. It communicates a violet colour to borax. Heated with sulphuric acid, it gives out oxygen gas; but with muriatic acid, it exhales the odour of chlorine.

From recent researches, it appears that the variety known by the name of *wad*, differs in containing a portion of water, and it has the chemical name of hydrated peroxide of manganese, although all the varieties of this oxide are indiscriminately applied to the same uses in the arts. These are in the preparation of chlorine for bleaching, and in the manufacture of glass. It is not improbable that it may be found in this State in considerable quantities, of a sufficient degree of purity for all these purposes.

Columbia County. According to Mr. Mather, wad is found in some abundance in a narrow range in this county. "It is deposited," says he, "from solution in water, in marshes, like bog iron ore. It has been found in quantity only in the vicinity of a range of slate, injected with quartz veins, which contain brown spar. When this spar is decomposed, oxide of manganese remains, which frequently retains the crystalline texture of the spar. This quartz, when exposed to the air, soon loses the brown spar by decomposition, and becomes cellular in consequence. The manganese of the wad is supposed to be derived from the brown spar which has been decomposed, and the constituents of which have been transported by water into the low grounds where the manganese is deposited. Brown spar is composed of the carbonates of lime, magnesia, iron and manganese; and as these bodies are isomorphous, they may replace each other without changing the crystalline form. The brown spar of this range of rock seems to contain an unusually large proportion of manganese."*

Such is the explanation given by Mr. Mather of the occurrence and mode of formation of this mineral, to which I have nothing to add at present. Several localities have been noticed in this county, among which are the following, viz:

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* *New-York Geological Reports*, 1838.

On the farm of Mr. H. W. Gott, two miles west of Austerlitz, where it occurs in a marsh, and is deposited like bog iron ore. It is thought to be an extensive bed.

On the farm of Mr. Judson Park, a mile south of the above, there is said to be another bed of the same mineral.

Several similar localities are reported to exist in the northeastern part of the town of Austerlitz.

Also on the farm of Mr. David Parsons, three quarters of a mile south of Canaan Centre; and on the farm of Mr. Joseph Goodsell, in the town of Hillsdale, &c.

Mr. Mather states, that in the counties of Columbia and Dutchess, 50,000 tons of wad could be procured without any great expense. If carefully prepared, it would be worth $20 a ton, or for the whole amount $1,000,000.

In Cattaraugus County, the black oxide of manganese has been found in small grains in various parts of the Conewango and Little valleys; but the quantity is too small to give it any value. The same is also true in regard to the occurrence of the hydrate of manganese in the County of Allegany; the lamellar variety of which, according to Mr. Vanuxem, is found associated with calc tufa near Angelica.

Essex County. On the sands near the village of Keeseville, there occur small rounded masses of a reddish brown colour externally, which, upon analysis, are found to contain a considerable proportion of oxide of manganese.

Lewis County. On the summit of Tug hill, about two miles from the village of Houseville, there is a bed of the earthy oxide of manganese in a marsh. It varies in depth, as at present exposed, from three to eight inches, being made up of rounded masses of various sizes. It is somewhat doubtful whether this is an extensive bed, and I am not aware that any means have been taken to determine the point.

New-York County. This mineral has long been known upon the Island of New-York, where it occurs in hollow friable masses in alluvial hills. The quantity, however, is small.

Orange County. Four miles southeast of Warwick, there is a compact variety of the oxide of manganese, which, however, is largely mixed with oxide of iron and earthy matters.

Westchester County. In the dolomite near Sing-Sing, there are occasionally found nodules of compact black oxide of manganese. They possess a higher specific gravity than most of the specimens of wad already described, and have a minute portion of copper combined with the manganese. They may belong to the variety noticed by Cleaveland under the name of *Cupreous Oxide of Manganese.*

These, with the addition of the small masses occasionally met with in the slates of Albany and Rensselaer Counties, constitute the New-York localities of this mineral. It is usually quite largely mixed with the oxide of iron and other foreign matters, which would of course detract from its value as an article of commerce. The following table will exhibit the results of the several analyses which I have made of this substance from different localities.

TABLE

Showing the composition of various specimens of Wad, from the State of New-York.

	I.	II.	III.	IV.	V.	VI.	VII.
Peroxide of manganese,	68.50	58.50	50.50	53.00	33.40	11.45	26.66
Peroxide of iron,	16.75	22.00	24.50	32.15	34.10	28.20	6.00
Earthy matters, (silica and alumina,)	3.25	2.50	4.50	6.90	8.75	44.75	57.50
Water,	11.50	17.00	20.50	6.85	24.00	15.60	and loss, 9.83
Copper,	------	------	------	traces.			

No. I. — Specimen from the farm of Mr. Joseph Goodsell, two miles northwest of Hillsdale, Columbia county. Earthy, friable, of a blackish brown colour.

No. II. — From the farm of Mr. H. W. Gott, two miles west of Austerlitz, Columbia county. External characters similar to those of the preceding.

No. III. — From the farm of Mr. David Parsons, three quarters of a mile south of Canaan Centre, Columbia county. External characters similar to the former. The specific gravity of this and the two preceding is not above 3.

No. IV. — From Sing-Sing in Westchester county. Colour bluish or brownish black; compact. Specific gravity 4.33. Found only in small masses in dolomite.

No. V. — Found near Keeseville, Essex county. Occurs in rounded masses about the size of a pea, brownish black in the centre, earthy, friable. It contains a large proportion of water and oxide of iron.

No. VI. — From Tug hill, Lewis county. Colour jet black or brownish black; earthy, friable. This specimen was very impure, but I cannot doubt that there are others possessing a larger proportion of the oxide of manganese.

No. VII. — Four miles southeast of Warwick in Orange county. Specimen compact, and highly siliceous; colour black.

TITANIUM AND ITS ORES.

The metal titanium was discovered in 1791, but its properties were not satisfactorily determined until the year 1822, when Dr. Wollaston found it in a slag at the bottom of a large smelting furnace in Wales. It has since been found at several other iron works in Great Britain. Dr. Emmons obtained this metal from the hearth stone of an iron furnace in St. Lawrence county, and I have detected it also in the slag of the Greenwood furnace in Orange county. It usually occurs in the form of cubic crystals, which in colour and lustre resemble burnished copper. In my specimen there is also associated with the metal a coating of a beautiful purple colour, which may be the oxide of titanium, supposed to exist only in the rare mineral called *anatase*.

There is another oxide of titanium, now more correctly termed titanic acid, which exists in variable proportions in several of the ores of iron, and from the decomposition of which, during the smelting of these ores, the metallic titanium is obtained. This substance closely resembles

silica in many of its characters; and when in considerable proportion, it is supposed to have an injurious effect upon the quality of the ore with which it is associated. In its pure or nearly pure form, it is used for the purpose of giving a yellowish tint to artificial teeth; and in consequence of its comparative scarcity, and the difficulty of its separation from other substances, is sold at a high price.

Of the titaniate of iron in the crystalline form, and now known by the name of crichtonite, we have an interesting locality in Warwick in Orange county, where it is imbedded in a dark coloured serpentine; and variable proportions of titanic acid are also contained in several of the iron ores of St. Lawrence, Jefferson and Orange counties.

ORES OF ARSENIC.

Arsenical pyrites, from which the compounds of arsenic used in the arts are obtained, has been found in this State, in the counties of Essex, Orange and Putnam.

Essex County. Small veins of this mineral occur in the town of Lewis; but the quantity which exists there, I have reason to believe, is quite inconsiderable.

Orange County. There is a locality of arsenical minerals on the lands of Mr. B. Hopkins, near the village of Edenville, which is particularly deserving of notice. Arsenical pyrites, composed of arsenic, sulphur and iron, occurs here in a vein in the white limestone. Associated with this is the arseniate of iron, or cube ore, as it is called from the primary form of its crystal, which here forms a coating to the preceding, and possesses a beautiful green colour and an adamantine lustre. Every where investing these two minerals is a powder of a lemon-yellow colour, which is ascertained to be the sulphuret of arsenic or native orpiment. In another part of the same vein is found a considerable quantity of the red oxide of iron, which, together with the sulphuret of arsenic, has undoubtedly been produced by the decomposition of the arsenical pyrites. And in addition to these metallic minerals, we have also arragonite in delicately radiated fibres, and of a snow-white colour, and occasionally thin laminæ of transparent sulphate of lime or selenite. On the whole, this is one of our most interesting localities, not only on account of the minerals which it affords, but of the apt illustration which it presents of the changes produced in the mineral kingdom through the influence of chemical agencies.

Putnam County. Near Brown's quarry are two localities of arsenical pyrites, one of which has, at some former period, been extensively worked. The ore, which might be used for the extraction of arsenic, seems to be abundant; but the present condition of the mine renders it difficult to arrive at a certain conclusion on this subject. Its reported mixture with silver, is probably one of those stories circulated for selfish purposes; and the only ground for it in the present instance, is the fact that in other countries the arsenical ores are often associated with those of a more valuable metal.

MAGNESIAN MINERALS.

Several minerals are found on Staten Island, and also in other parts of the State, which, in consequence of their containing large proportions of magnesia, may properly enough for my present purpose be grouped together under the name of magnesian minerals. Some of these may be turned to account in the arts.

The mineral called serpentine constitutes the principal range of hills on Staten Island, extending from New-Brighton to a little west of Richmond, a distance of eight miles. It assumes a great variety of aspects, from black to nearly white, and from compact to earthy. Some of the talcy varieties are commonly known by the name of soapstone. Talc, carbonate of magnesia and hydrate of magnesia abound in it, and the rock might be used with profit in making magnesian salts.*

The suggestion here made in regard to the preparation of magnesian salts from the minerals so abundant on Staten Island, is deemed worthy of great consideration. These minerals contain from one third to two thirds of their weight of magnesia, as will be seen from the following results of their analysis.

TABLE

Showing the composition of several Magnesian Minerals, especially in reference to the proportion of Magnesia which they contain, in 100 *parts.*

	Magnesia.	Lime.	Carbonic acid.	Water.	Silica.	Protoxide of iron.	Peroxide of iron.	Foreign matters, and loss.
1. Hydrate of magnesia,†	70.00	-----	-----	30.00				
2. Hydrocarbonate of magnesia,‡	42.41	-----	36.82	18.53	0.57	-----	0.27	1.40
3. Compact carbonate of magnesia,◊	44.00	3.50	50.00	-----	2.00	0.50	& alumina,	
4. Magnesite or kerolite,‖	41.26	2.39	-----	13.50	41.00	-----	& alumina,	
5. Common serpentine,¶	42.16	-----	1.03	12.33	42.26	1.98	1.85	

No. 1. From Staten Island, and Hoboken, New-Jersey.
No. 2 and 3. From the same localities.
No. 4. From Staten Island, Stony Point, Rockland Co. etc.
No. 5. Found in various parts of the State.

The magnesia contained in either of these minerals would furnish, by combination with sulphuric acid, upwards of two hundred parts of sulphate of magnesia or Epsom salts, in the form in which it is ordinarily sold in the shops. Moreover, the sulphate of magnesia, thus obtained, may be decomposed by carbonate of soda or potash, and produce carbonate of mag-

* Mather. *New-York Geological Reports*, 1838.
† Bruce. *American Mineralogical Journal*, I. 26.
‡ Wachmeister. *Silliman's Journal*, XVIII. 167.
◊ Nuttall. *Silliman's Journal*, IV. 17.
‖ By my analysis. The specimen was from Staten Island.
¶ Thomson. *Outlines of Mineralogy, &c.*

nesia, which, as well as the sulphate, is used for medicinal purposes.* By this operation, when serpentine is employed, a large quantity of Venetian red is also procured, as that mineral contains a considerable proportion of oxide of iron. This manufacture is now carried on near Baltimore in Maryland, and there seems to be no reason why it may not be profitably pursued in the vicinity of New-York.

Serpentine, similar in every respect to that found on Staten Island and at Hoboken in New-Jersey, occurs in considerable abundance in the counties of New-York, Westchester, Putnam, Rockland and Orange; and extensive deposits of the same mineral are also found in the county of St. Lawrence.

The beautiful green colour of serpentine, and the fine polish which it takes when pure, give it great value as an ornamental marble. When mixed with granular limestone, it forms the celebrated *verd antique*. Unfortunately in almost all the localities in the southern part of the State, at least so far as they have been explored, the serpentine, although in great abundance, is so mixed with carbonate of magnesia, asbestus and other magnesian minerals, as to render it unfit to be worked as a marble. Thus a block obtained from a quarry in the county of Westchester, concerning which high expectations had been raised, was found to have an unequal degree of hardness in its different parts, and to be filled with seams and nodules of other magnesian minerals which could not be polished, or were too friable to sustain the rough usage which is required for the dressing of marble.

Dr. Emmons informs us that there are several localities in St. Lawrence county, in which the soundness of the serpentine rock is remarkable; and the only impediment to the introduction of this article for ornamental and useful purposes, he thinks, is the expense of transportation. At Pitcairn, is a fine locality of *verd antique*. The colours are green and white, arranged in the usual forms of clouded marble. The serpentine has a bright green colour, and belongs to the variety usually called precious. The carbonate of lime is white, and forms a handsome ground for the translucent serpentine.†

Usually associated with serpentine, when it occurs in extensive beds, is a mineral which has nearly the same chemical composition, generally known by the name of soapstone. This is particularly the case in the counties of Richmond and St. Lawrence. In consequence of its softness and tenacity, soapstone may be turned or cut into articles of various shapes, and rendered hard by exposure to heat. It is hence much used for the hearths of furnaces, the sides of fireplaces, the linings of stoves, and for other similar purposes.

Another substance often found with these magnesian minerals, is asbestus, under which I include the variety composed of flexible silky fibres, sometimes known by the name of amianthus, there being no line of specific distinction to warrant its separation. This mineral has

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* Should the preparation of these salts of magnesia become important, the dolomites or double carbonates of lime and magnesia which occur at Sing-Sing and elsewhere, may be also advantageously employed for that purpose. The double carbonate is first to be calcined, and then treated by sulphuric acid or sulphate of iron. There is thus formed an insoluble sulphate of lime and a soluble sulphate of magnesia, which can be easily separated.

† Emmons. *New-York Geological Reports*, 1838.

acquired notoriety, from the fact that some of its varieties may be woven into cloth which is indestructible by heat. It is to uses similar to these that it is accordingly applied, being employed in the preparation of the incombustible cloth proposed for firemen's robes, and for the lining of the metallic safes now so generally introduced into counting houses.

MATERIALS FOR BRICKS, POTTERY AND PORCELAIN.

The localities of clays suitable for the manufacture of brick and the common kinds of earthen ware, are too numerous in this State to be here introduced, and their description belongs rather to the department of geology than to that of mineralogy. Many of these have already been noticed in the Reports of the Geologists; and Mr. Mather has presented some details, which show the importance of the branch of industry included under the art of brick-making.

The manufacture of the finer kinds of pottery has not heretofore been carried on with much success in our country. Whether this be owing to the superior facilities which are possessed by the English and French in regard to materials, or to the reduced price of labour, it is not easy to determine. My present object is merely to show that New-York is not destitute of the materials necessary for this branch of art.

The finer kinds of pottery require for their manufacture the purest clays; such as contain little or no oxide of iron, and which consequently do not turn red in burning. To these a portion of pure silica is added, which is prepared for the purpose by heating masses of flints or quartz, quenching them in water, and then reducing them to powder in a mill.

Clays of good quality occur abundantly in various parts of Staten and Long Islands; and upon proper trial, they would no doubt be found to answer the purposes of this manufacture. There are also several localities in Orange county, where similar materials may be obtained.

Near Southfield furnace in the latter county, is a bed of decomposed feldspar, known by the name of porcelain earth, which will probably be of great value in the manufacture of pottery. This substance is of a pure white colour when dry, a little unctuous, and is supposed to be abundant.

According to Dr. Emmons, porcelain clay, arising from the decomposition of labradorite, occurs near the village of McIntyre in the county of Essex. There is also an important locality at Minerva in the same county.

In Warren county, porcelain clay is found in abundance in the towns of Athol and Johnsburgh. It is white, soft to the touch, and probably contains an admixture of talc. The white is interlaminated with layers of different colours, as yellow, red and brown. The quality of this clay has, upon trial, been ascertained to be good.

It is now generally admitted that these clays owe their origin to the decomposition of feld-

spathic rocks, but the precise nature of the changes which take place has not yet been ascertained.

As for feldspar, used in glazing, and also in the body of the finer kinds of pottery, we have several localities in Orange county, in Warren county near Caldwell, and also in the counties of Jefferson and St. Lawrence; while quartz, of a good quality and in sufficient abundance for the same purpose, is found in Orange, Columbia and other counties.

Those who are at all acquainted with the history of the arts, both in this and in other countries, must be aware that their progress has oftentimes been extremely slow; and it will not be surprising if the manufacture in question, although now of so little value to us, should become an extensive and important one. Previously to about the year 1760, England depended wholly upon other countries for the finer kinds of pottery, the English ware being generally of an inferior quality; but in a few years after the investigations and consequent improvements of Mr. Wedgewood, the current of importation of even the finer earthen wares was changed in that country to exportation, and their manufacture has at length become of such vast extent that it is not easy to calculate its value. So it has been with many of the arts now successfully prosecuted in our own country. A great number of articles, for which we were but a few years since entirely dependent on foreign nations, are now manufactured by our mechanics and in our own workshops.

STONE PAINTS, OCHRES, &c.

In my notice of our iron ores, it has been remarked that many of the varieties of the specular oxide of iron, and of the limonite, in different parts of the State, are employed as paints. They answer well for this purpose, not only in consequence of the fine colour which they often possess, but of the manner in which they unite with oils.

There are some other minerals which may be noticed here, in consequence of the use which has been made of them as paints. I refer now to the sulphate of barytes and the carbonate of strontian. The former of these minerals, which can easily be distinguished from marble which it sometimes resembles, by its greater specific gravity, is now used quite extensively as a substitute for white lead. Of this mineral we have several localities, but it has not heretofore been found here in so great abundance as in some of the neighboring States. At Pillar Point in Jefferson county, it has been obtained in large blocks, and is compact, variously coloured, and susceptible of polish. It is also found in St. Lawrence, Herkimer, Greene and Schoharie counties.

The carbonate of strontian, of which a stratum occurs at Schoharie, might be employed for a similar purpose; as its specific gravity, although not quite so high as the sulphate of barytes, is higher than that of most other earthy minerals. It is, moreover, of a white colour, and is easily reduced to powder.

The sulphate of barytes is often used to adulterate white lead; nor is it easy, without a chemical examination, to detect its presence in the mixture. As a paint, the mixture answers equally well in most cases; but it can, and should, be sold at a much cheaper rate than the pure white lead.

Other materials, which abound in this State, have recently been introduced as lithic paints, as soapstone and serpentine. Prof. Hitchcock states that these substances are ground with whale oil; and in Connecticut, where they have been manufactured, they are sold for five dollars per hundred pounds. They answer a good purpose as a basis for common paints, especially for the roofs of houses.*

CALCAREOUS MINERALS.

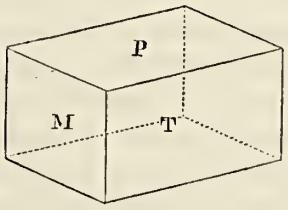
Under this general head, I shall notice Gypsum, Marble, Hydraulic or Water Limestone, and Marl; all of which occur very abundantly in this State.

HYDROUS SULPHATE OF LIME. *Thomson.*

Gypsum. *Phillips.*—Chaux sulphatée. *Hauy.*—Sulphate of Lime. *Cleaveland.*—Prismatoidal Gypsum, or Common Gypsum. *Jameson.*—Prismatoidisches Gyps-Haloid. *Mohs.*—Gypse. *Beudant.*—Gypsum. *Shepard* and *Dana.*—(Includes Selenite, Alabaster, Earthy Gypsum, and Plaster Stone.)

Description. Colour snow-white when pure; but it is often red, yellow, blue and grey. When crystallized, it is foliated; but it occurs also fibrous, granular and compact. The foliated varieties are called *Selenite*, from their fine white colour. They split into thin leaves parallel to the base of a right oblique prism, the faces of which are inclined to each other at angles of 113° 8′ and 66° 52′.

Fig. 13.



Lustre of the lateral faces of the prism, vitreous; that of the base, pearly. Varies from translucent to transparent. Hardness 2; may be scratched by the nail.

Specific gravity of a transparent white crystal from Oxford, as determined by Hisinger, 2.310; from 2.3121 to 2.3257 (*Beudant*).

The compact varieties of this mineral are often known by the name of *Alabaster*.

Composition. This mineral is composed, in 100 parts, of sulphuric acid, 46.00; lime, 33.00; water, 21.00.

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* Report of a Re-examination of the Economical Geology of Massachusetts, 1838.

When heated, the water is easily driven off; and it then acts before the blowpipe like the anhydrous sulphate of lime, being with difficulty fused into a white enamel. When the anhydrous powder is mixed with water, it forms a paste, which soon becomes solid, and is on that account used for taking casts of statues, in stereotyping, &c. It is said to be better suited for this purpose, by mixing it with about one third of its weight of carbonate of lime. The *Plaster of Paris*, so called because it is found near that place, is such a compound; and one similar to it is found in the gypsum beds of Western New-York. The following is the composition of a specimen from Montmartre,* viz:

Sulphuric acid,	41.00
Lime,	29.39
Carbonate of lime,	7.63
Insoluble matters,	3.21
Water,	18.77

Distinctive characters. Gypsum may be distinguished by its inferior hardness, and by the action of acids, from the carbonate of lime, to which it often bears a resemblance.

Almost all the different varieties of this species are sometimes found in one of our extensive beds, and they are indiscriminately used for all those purposes to which gypsum is applied. The chief uses are in agriculture as a manure, and in the preparation of stucco for walls.

I shall describe the localities of this useful mineral in the alphabetical order of the counties in which they are found.

Albany County. Specimens of snowy gypsum have been found in the Helderberg mountains; and in the town of Coeymans, it occurs in an alluvial bed twenty or thirty feet thick, where it effloresces on the sides of excavations made by rivulets and for roads. But its occurrence here is not in sufficient abundance to answer any useful purpose. Indeed it will be presently observed, that the only important beds of this mineral are in the district bordering on the Erie canal.

Cayuga County. There are several important beds of gypsum in this county. Near Troopsville, the earthy variety is found in large quantities. The same mineral is also abundant at Cayuga Bridge; but the largest number of beds have been opened south of the bridge, and two miles north of Union Spring, and near the lake shore. Here are five plaster quarries; and to the east of these is another, owned by Mr. Thomson, which is remarkable for the numerous seams of native sulphur which it contains. The thickness of the rock is from eight to eighteen feet; in many places it appears at the surface of the earth, and covers an area of a mile square. A specimen of the plaster stone from this bed, when freed from water, gave the following results, viz:

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* Beudant. *Traité Elémentaire de Minéralogie*, II. 469.

Sulphate of lime,	71.75
Carbonate of lime,	21.65
Clay, coloured by oxide of iron,	6.60

In regard to the above quarries, Mr. Vanuxem remarks, that they lie farther to the south than any known in the district; extending with the lower deposit found at Montezuma, along a north and south line of about thirteen miles. For quality, they are superior to any in the district; the masses are also larger, yielding often from 300 to 1000 tons. These quarries furnish about 10,000 tons annually; and the value, delivered at the head of the lake, is from $1.50 to $2.00 per ton.*

Specimens of selenite have been found in the clay near Hudson, in Columbia County.

Genesee County. Beds of gypsum have been found in various parts of this county, especially in the northern part of Leroy and Stafford, and in the western part of Elba. The gypsum at the former of these localities, is often free from admixture of clay; but usually it is more impure, and when exposed to the atmosphere, crumbles rapidly. The masses are described by Mr. Hall as being more or less spherical; the surrounding rocks being raised in the centre, and presenting a fractured convex surface, dipping on every side of the mass. According to his estimate, the different plaster beds in this county yield about three thousand tons annually.

Herkimer County. The west end of the town of Stark in this county, is the most eastern point at which gypsum has been found in any great abundance. According to Mr. Vanuxem, it occurs in a white sandstone, the grey band of Prof. Eaton; and he represents it as being white, and equal to the Nova-Scotia both before and after calcination. From twenty to thirty tons had been obtained by Mr. Crill, the proprietor, during the summer of 1837. Since that time, I had received no information in regard to this locality.

In the cabinet of the Albany Institute, there is a specimen of crystallized gypsum from Danube in this county; but I am not able to say whether it occurs there in any abundance.

Livingston County. Beds of this mineral, in almost all its varieties, occur in various parts of this county, as in Caledonia, Leicester and Mount-Morris; but I have no means of determining their value.

Madison County. It was here that gypsum was first ascertained to be one of the important mineral products of New-York. All the quarries at present known are south of the Erie canal, in the towns of Sullivan and Lenox, where there are several which are still actively worked. The old Sullivan or Patrick bed, which was the first that was discovered in Western New-York, is in the town of Sullivan.

The gypsum found in this county is sometimes foliated and granular, but usually it belongs

* Vanuxem. *New-York Geological Reports*, 1839.

to the common or impure variety, being mixed with carbonate of lime and clay. It occurs imbedded in gypseous marl, every where forming irregular or somewhat rounded conical masses or hillocks, rarely more than forty or fifty feet in diameter, and usually from ten to twenty feet in height. The masses of gypsum are a foot or more in thickness, and weigh from four to six hundred tons. I can give no details concerning the amount of this mineral annually raised in this county; but in 1837, I was informed that in the town of Sullivan alone there were raised from four to seven thousand tons annually.

Monroe County. Several specimens of foliated gypsum, of a rose colour, were found below the Falls of the Genesee at Rochester, many years since; and nodules of the snowy variety occur in the limestone at the same locality. Gypsum is also obtained in small quantities in the towns of Pittsford, Riga and Chili; but according to Mr. Hall, the workable beds of this mineral are almost wholly confined to the southern part of the county. "Along the valley of Allen's creek and Mill creek, two miles north, most of the plaster of Monroe county is obtained. Both these places are in the town of Wheatland. About 5000 tons of gypsum per annum are obtained from this town; of this quantity, 4000 tons are used in this county."*

Niagara County. The localities of the hydrous sulphate of lime in this county are of considerable interest to the mineralogist. At Lockport, beautiful specimens of transparent selenite and snowy gypsum have been found, associated with calcareous and pearl spar, sulphate of strontian, and the rare anhydrite or anhydrous sulphate of lime. Snow-white granular gypsum also occurs near the Falls of Niagara, with occasional specimens of foliated selenite of a bluish colour. At all these localities, the gypsum is imbedded in the geodiferous limerock of Prof. Eaton; but it does not, so far as I am informed, occur in quantities sufficient for useful purposes.†

Oneida County. Gypsum is found here in beds of vast extent. It is often foliated and transparent; but the largest proportion is of the impure kind, mixed with carbonate of lime. This last, however, is almost equally valuable for agricultural and other purposes.

Onondaga County. The interesting region around Onondaga lake contains, in addition to its other sources of wealth, some important deposits of gypsum. At Liverpool, the fibrous variety, then comparatively rare in this State, was found several years since, about twelve feet below the surface of the earth, associated with marly clay. The excavations made for the construction of the railroad from Syracuse to the Split Rock quarry, opened an extensive bed of the same mineral. At this locality are to be found several varieties; as the foliated, the fibrous, the snowy, and the common or dark coloured; the whole imbedded in a kind of gypseous marl, which effervesces freely in acids, and contains variable proportions of the oxide of iron. Gypseous beds, similar in their general characters, also occur in the vicinity of Man-

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* Hall. *New-York Geological Reports*, 1838.

† Mr. Hall thinks that hundreds of quarries of plaster might be opened along the line of the limestone terrace, from Black-Rock eastward. *New-York Geological Reports*, 1841.

lius, from which large quantities have been exported. But probably the most valuable deposits that have yet been opened up, are those along the line of the Auburn and Syracuse railroad, near the village of Camillus. We find here, among other varieties, noble specimens of transparent selenite; and what renders the locality peculiarly interesting, are the associated strata of calcareous tufa, and of the singular hopper-form crystals of marly clay. From forty to fifty thousand tons of gypsum were obtained simply from the excavations which were necessary for the construction of this road; and this may be considered as merely a specimen of what is still hidden in the adjoining hills.

Plaster beds occur also in the town of De Witt and elsewhere in this county; and it may be added as an interesting fact, that minute crystals of sulphate of lime are apparently in the process of constant formation on the exposed surfaces of the marly clay or gypseous marl found near Camillus.

Ontario County. Beds of gypsum are found, and extensively quarried, on the banks of the outlet of the Canandaigua lake in the town of Phelps, between Vienna and the town line of Manchester. West of this point, one or two masses are seen in the bank of the outlet; and with this exception, and a single bed opened near Victor, the town of Phelps furnishes nearly all the gypsum from this county. There are about six thousand tons annually ground at the mill at the outlet.*

Orange County. There are occasionally found thin plates of selenite in the fissures in magnetic iron ore, and in the seams of arsenical pyrites, near Edenville in this county. These are merely interesting as mineralogical specimens. The same is also true of the occurrence of minute crystals of sulphate of lime at the Sharon sulphur springs in Schoharie County. These crystals, which are needle-form and very minute, are deposited in consequence of the evaporation of the water, which holds sulphate of lime in solution.

Seneca County. Near Seneca falls, there are beds of gypsum extensively wrought, and large quantities of plaster are sent from thence into the counties of Chemung and Steuben. From five to six thousand tons is supposed to be the annual produce of these quarries.

Tompkins County. Beds of gypsum occur in this county, in the calciferous slate. I have no information in regard to the amount obtained.

Wayne County. At Lyons, the fibrous variety was several years since found, fifty feet below the surface of the earth. Gypsum has been found both at Clyde and Palmyra, but at some distance below the surface.

About two miles west of Newark are two hills on either side of the canal, from which gypsum is quarried. It is mostly lamellar, transparent, and of that variety sometimes known by the name *isinglass plaster*. It is often, however, of a reddish colour, and is mixed with, or disseminated through, a calcareous or argillaceous marl.†

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* Hall. *New-York Geological Reports*, 1839.

† Dr. G. W. Boyd. *New-York Geological Reports*, 1838.

A very imperfect idea of the quantity of gypsum which exists in this State, will be obtained from the account of it which has now been given. Even if we had the means of ascertaining exactly the number of tons at present annually raised, which I think cannot be less than fifty thousand, it should be borne in mind that regular explorations are seldom undertaken; and that the amount, whatever it may be, is mainly the result of accidental discovery, and of occasional labour by the farmer during the intervals of his other avocations. Immense beds still lie unopened, which will at some future day yield their treasures. Perhaps one reason why greater attention has not been paid to the enormous deposits of gypsum and marl which exist in the western part of the State is, that the soil is naturally so fertile as seldom to require the employment of those artificial means of renovation which in most other countries are necessary to the success of the agriculturalist. Still it cannot be doubted that in many situations even here, much advantage would be derived from the use of these efficient fertilizers. Lime, marl and gypsum, all of which can be so easily and so abundantly obtained in many parts of our State, have almost entirely changed the agricultural character of New-Jersey and Pennsylvania. With us, however, their great value does not yet appear to be duly appreciated.

It may not be out of place here to offer a few suggestions in regard to the origin of gypsum.

From the uniformly regular appearance which the beds of gypsum present throughout the western counties, the similarity in their geological associations, and the apparent heaving up of the strata which enclose them, it has been thought that they are the result of agencies now in operation. The opinion indeed prevails quite generally among the inhabitants of the districts where plaster beds are of most frequent occurrence, that they increase from year to year, and that it is unsafe to commence important structures in situations where they are supposed to exist.

It seems not improbable that the sulphate of lime has been formed subsequently to the deposition of the strata of limestone in which it is found, and that it may belong to that class of bodies whose formation is continually going on. The decomposition of the sulphuret of iron, and the subsequent action of the sulphuric acid thus produced upon limestone, has by some been proposed as the mode in which this is accomplished. But a formidable objection to this view is, that iron pyrites, although a very common mineral, is not yet found in sufficient quantity to account for the vast results which have been ascribed to it. Thus in the western part of New-York, the occurrence of gypsum, the formation of vast beds of iron ore, and the production of the immense number of sulphur springs which are known to exist there, have all been referred to the decomposition of this single mineral.

If all these phenomena were really due to the decomposition of iron pyrites, it would be fair to infer that this substance existed in enormous quantities; and that beds of oxide of iron, resulting from this decomposition, should uniformly be found in the immediate vicinity of our plaster beds and sulphur springs. But the facts in these cases do not accord with the theory.

As all our sulphur springs contain sulphate of lime, and as they are most numerous and copious in those parts of the State where gypsum beds abound, it may, I think, without violence, be supposed that the production of gypsum, and the evolution of sulphuretted hydrogen,

are referable to the same agency. May not this be the decomposition of a compound of sulphur and lime, or the metallic basis of lime, which may exist at different and unknown depths? But I shall leave these theoretical considerations, until I have completed the description of our sulphur springs. I will only add, that it is no objection to the explanation here proposed, that sulphur springs occur throughout the whole series of New-York rocks, while all the workable deposits of plaster are confined to one rock.

MARBLE.

The term *Marble* should perhaps be strictly confined to those varieties of carbonate of lime, whether included under the head of *granular* or *compact* limestone, which are susceptible of a polish, and some minerals of which carbonate of lime forms the principal ingredient. I shall apply it, in the present work, to all those varieties of limestone, or those minerals composed chiefly of carbonate of lime, which admit of being dressed or polished, and are employed for ornamental building purposes.

Description. The *foliated granular limestone*, or *crystalline marble*, is made up of distinct angular concretions, with a lower lustre and transparency than calcareous spar. These grains are of various sizes, from coarse to very fine. When this granular composition disappears, it becomes the *compact limestone*, which has a splintery or conchoidal fracture.

The specific gravity of marble is very variable, ranging from 2.40 to 2.84; the crystalline kinds being the most dense.

Colour various, owing to the admixture of foreign substances. When white, it is more or less translucent.

Composition. When pure, this variety has the same composition as calcareous spar, viz. carbonic acid 43.56, and lime 56.44, in 100 parts. But it is seldom found in this state of purity; almost always it contains silica, alumina and oxide of iron, the proportions of which sometimes reach ten or fifteen per cent.

Dolomite. The granular marble usually known by this name, differs from the preceding in composition, and in some other properties. It effervesces slowly in nitric acid; possesses a higher specific gravity than calcareous spar, and is a compound of carbonate of magnesia and carbonate of lime in somewhat varying proportions.

The following constitute the more important localities of marble in the State of New-York.

Clinton County. In the vicinity of Plattsburgh, there is a great abundance of black marble of the compact variety, containing organic remains. There is also a valuable quarry of a similar marble in Chazy, near the lake, and nearly opposite to Isle La Motte, and it is probably a continuation of the same range. When polished, it has a jet black surface, and is of great beauty.

Columbia County. Mr. Mather gives it as his opinion that beds of marble equal to those of Stockbridge and Egremont, exist in Hillsdale and Copake in this county. These beds furnish a marble, which, although dolomite, is highly esteemed.

Dutchess County. Beds of marble similar to those found on the borders of this State, in Massachusetts, exist in various parts of this county; as in the towns of Amenia, Dover, Pawlings, Beekman and Fishkill. The Dover quarries have been extensively wrought; and the marble which they yield, although dolomite, is pure white, fine grained, and takes a medium polish. Sometimes it is very friable, especially when first quarried. A specimen of this kind gave the following results upon analysis, viz:

Carbonate of lime,	60.50
Carbonate of magnesia,	39.50

Clouded marble also occurs in the towns of Northeast and Amenia, and among these are some which excel in regard to texture and durability.

All these, now comparatively neglected mines of wealth, would at once be opened up, if some easy and direct mode of communication could be established between them and the Hudson river.

Essex County. In the immediate vicinity of Port Henry on Lake Champlain, and elsewhere in this county, beds of white limestone occur, which would be suitable for marbles. The verd antique variety, consisting of grains of green serpentine diffused through the white limestone, is also found near Port Henry. It seems to be sufficiently free from cracks and flaws, and would no doubt bear a good polish. The same mineral also occurs abundantly at Moriah in this county.

According to my analysis, the limestone from Port Henry contains a portion of magnesia.

In Franklin County, beds of white primitive marble are abundant.

Jefferson County also contains deposits of a similar kind, but they have not yet been sufficiently explored to determine their real value.

Lewis County. Extensive beds of a dark and compact serpentine occur in the immediate vicinity of Natural Bridge. The specimens obtained from this locality are susceptible of a high polish; and it is probable that large slabs may be obtained free from checks or flaws, which would answer the purposes of an ornamental marble. Some of the beds belong to that peculiar variety which Dr. Emmons has named *Rensselaerite*,* but which seems to me to be nothing more than a mixture of serpentine and pyroxene.

New-York County. The quarries at Kingsbridge have furnished a considerable amount of marble. It is granular, and belongs to the dolomitic variety. By exposure to the weather, some of the specimens fall to pieces, and form a kind of calcareous sand. It is now, I believe, chiefly used for burning into lime.

Niagara County. The rock at the village of Lockport is sufficiently compact to be polished, and it has been used for some ornamental purposes. It contains fragments of organic

* *New-York Geological Reports*, 1837.

remains, which give it a variegated and beautiful appearance. It also frequently presents, on fracture, that singular columnar structure, at right angles to the layers, which has been quite aptly compared by Mr. Vanuxem to the sutures of the skull. In consequence of a suggestion made by that gentleman,* that the appearance in question was owing to sulphate of magnesia, I subjected a specimen to analysis, and found its composition to be as follows, viz :

Carbonate of lime,	75.65
Carbonate of magnesia,	20.70
Silica and alumina,	2.25
Oxide of iron,	0.35
Moisture and loss,	1.05†

Oneida County. In this county we have the Trenton limestones, which will furnish beautiful black marbles ; and the grey marble near the Holland patent, and on a branch of Steuben creek.

Onondaga County. In this and the adjoining county (Madison), the grey crinoidal limestone affords a marble scarcely excelled by any in the country for beauty, durability, and the fine polish which it receives. The quarries in Onondaga county are moreover very extensive, and yield blocks of great size. The marble is not only used for ornamental purposes, but in its dressed state is employed in the construction of locks, aqueducts, and other similar structures. The public works recently constructed in the vicinity of Syracuse present a striking proof of the superiority of this material over that formerly used for similar purposes, while at the same time they offer a no less striking illustration of the great advances which have been made in the arts of construction in this State.

I have analyzed two specimens of the grey crinoidal limestone, the one from the quarry near the Chittenango falls in Madison county ; the other from the Split Rock quarry in Onondaga county. The following are the results — No. I. is from the former, No. II. from the latter :

	I.	II.
Carbonate of lime,	98.50	99.30
Oxide of iron,	0.35	0.20
Insoluble matters (silica and alumina),	0.90	0.40

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* *New-York Geological Reports*, 1838.

† I have also analyzed a specimen of limestone from the bed of the river at Rochester, Monroe county, called "Calciferous Slate" by Prof. Eaton, and "Calcareous Shale" by Mr. Hall. It is bluish grey, a little crystalline, and emits a strong bituminous odour when struck or subjected to heat. Its composition is,

Carbonate of lime,	44.65
Carbonate of magnesia,	30.00
Silica, with a little alumina,	24.00
Oxide of iron,	1.00
Bituminous matter,	0.30

This bituminous matter occurs in many of the limestones which I have examined. It is found in the residuum unacted on by acids, and, when subjected to heat, gives out an odour resembling that of burning peat.

In Otsego County, a good marble has long been known in the vicinity of Cherry-Valley; and in Orange County there are several localities of marble, but none of them are at present wrought.

Putnam County. Probably no county in the State contains a more abundant supply of marble than this. In the northern part of the town of Kent there are beds of coloured marble, while in Phillipstown and Patterson the white variety abounds. In the vicinity of the village of Patterson there are extensive beds which have been much wrought for several years, both for building purposes and for burning into lime. The marble, which is here granular and dolomitic, is white or bluish white, and closely resembles that from Sing-Sing in Westchester county. Like that also the strata are often traversed by tremolite, asbestus and pyroxene.

In the vicinity of the County Poor-House are extensive beds of dark serpentine, which takes a good polish, and no doubt will hereafter be much used as an ornamental marble. It is compact, and may be obtained in blocks of large size, free from checks and flaws. But for the fact that these beds are situated at too great a distance from water transport, they would long ago have been extensively wrought.

Rockland County. About two and a half miles west of Grassy Point, there is a beautiful variegated marble, which is susceptible of a fine polish, but it does not appear to be abundant. Associated with this are sometimes found epidote, crystallized hornblende and feldspar. A quarry of dove-coloured marble occurs on the banks of the Minischecongo creek, of which the following is the composition, viz :

Carbonate of lime,	93.50
Insoluble matter (silica, &c.)	3.75
Moisture and loss,	2.75

So that it is sufficiently pure to be burned into lime.

There is a quarry of verd antique marble on the immediate bank of the Hudson, about a mile and a half below Caldwell's Landing. It is said that blocks of any reasonable size can be quarried here, free from cracks and flaws.*

St. Lawrence County. From the abundance of white limestone in this county, it cannot be doubted that it contains many and valuable localities of marble; but there have been as yet few inducements for explorations of this kind. Between the villages of Oxbow and Gouverneur, there is a bed from which blocks of good white marble have been obtained. There is another locality near Potsdam, which furnishes a good and easily wrought marble; while of verd antique, extensive beds are found in Gouverneur, Fowler and Edwards. Another locality of the same kind occurs in Pitcairn. The colours are green and white, arranged in the usual forms of clouded marble. The serpentine has a bright green colour, and belongs to

* Mather. *New-York Geological Reports*, 1839.

the variety usually called precious. The calcareous spar is white or greyish white, and forms a handsome ground for the translucent serpentine.*

Warren County. Perhaps the most important deposit of marble in this county, although there are several, is that of Glen's Falls. Dr. Emmons has given a detailed account of this in his Report of 1839. The marble is black, and for brilliancy of polish and beauty of colour it is almost unrivalled. The whole stratum is ten and a half feet thick; this, however, is often traversed by veins of organic remains, which somewhat injure the quality of the marble. The quarrying and sawing of this marble is now extensively carried on.

Elsewhere in this county are beds of compact limestone similar to the above, but they are not worked to any extent. Ledges of dove-coloured marble are found at the head of Lake George; while of the verd antique variety, there are valuable localities in Warrensburgh, Athol and Johnsburgh.

Near Granville in Washington County, clouded marble has long been known to exist.

Westchester County. Important beds of marble are known to occur in various parts of this county. Those of Sing-Sing are, on several accounts, deserving of particular notice. The following remarks will be found to be generally applicable to all the marbles of the county.

The Sing-Sing marble is granular, and sometimes so friable that it can be crushed between the fingers. This tendency to disintegration is very manifest in those parts of the strata which lie near the surface, and which often have the appearance of beds of sand. This marble, moreover, frequently contains masses of tremolite, quartz, and grains or crystals of iron pyrites; the two former rendering it sometimes difficult to be worked; and the latter, by its decomposition, causing reddish stains, which detract from the beauty of the material. It is, however, found to improve with the extent of the excavations, becoming more compact in its texture, and more free from these foreign minerals.

The ease with which this marble can be worked, its good colour, and, perhaps more than all, the facility with which it can be transported, will undoubtedly secure for it extensive use as a building material. The State being largely interested in these quarries, it is manifestly for its interest that the working of them should be conducted in the most judicious, as well as economical manner. By which I mean, that any reasonable outlay should be incurred, if by this a finer and more durable kind of marble can be rendered accessible.†

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* Emmons. *New-York Geological Reports*, 1838.

† The following remarks occur in a paper recently published, "*On the Building Materials of the United States of North America.* By David Stevenson, Esq. Civil Engineer, Edinburgh."

"The marbles of the United States, according to the account of many intelligent Americans with whom I have conversed on the subject, are not suited for sculpture or very fine ornamental works, or even indeed for the capitals of columns which require superior work; and the marble used for the capitals of all the fine buildings throughout the country is imported from Carara in Italy, whence a very large quantity is annually exported to America. For similar purposes, black marble is also imported into the States from Ireland. If, however, I might form a judgment from the quality of some specimens which I procured, I should think, that were the American quarries efficiently worked, there could be very little necessity for applying either to Italy or Ireland for so great an annual supply. Those buildings which are constructed of the whitest description of American marble carefully

The marbles of Sing-Sing, and almost all the others of this county, belong to the variety called dolomite. I made an analysis of a specimen from the vicinity of the State Prison. It consisted of small grains, feebly cohering; had a white colour, with a few dark spots. The results were the following:

Carbonate of lime,	53.24
Carbonate of magnesia,	45.89
Silica and alumina, with a trace of oxide of iron,	0.87

Quite similar to the beds just described, are those which occur in the vicinity of Hastings and elsewhere in the northern part of this county; and the same remarks will apply generally to the quarries at West-Farms and in Eastchester. The marble from the Eastchester quarries is perhaps more highly esteemed than any in the county. It is white and bluish white, coarse grained, and susceptible of a medium polish. It is less friable, and usually more free from foreign minerals, than that obtained at Sing-Sing. Blocks of large size and of uniform texture are quarried here, the strata being frequently several feet thick. Mr. Mather states, that at the time of his visit in 1838, they were quarrying a block 150 feet long, eight feet thick, and seven feet broad, and which it was thought would be worth $20,000. The marble obtained at these quarries is transported five or six miles by land carriage, and then shipped to New-York and elsewhere. The Custom House at New-York was built of this material.

A specimen of this marble, from Kane's quarry in Eastchester, was found to contain

Carbonate of lime,	61.75
Carbonate of magnesia,	38.25

The white limestone of this county, in addition to its employment as a marble, is also largely used for burning into lime, and this not only for home consumption, but also for export. At the Cold Spring furnace, it is used as a flux for the reduction of iron ore.

Besides the white dolomitic marbles already described, there occurs in the vicinity of New-Rochelle, Rye and elsewhere, serpentine in vast beds, which presents beautiful shades of colour, and in small specimens takes a high polish. Unfortunately, however, it is so mixed with carbonate of magnesia, asbestus and other foreign minerals, as to render it unfit to be worked as a marble. Thus a block from the vicinity of New-Rochelle, concerning which high expectations had been raised, was found to have running through it in every direction

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selected for the purpose, such as the Capitol and the President's House at Washington, the Bank of the United States, the Mint and other public buildings at Philadelphia, the Monument erected to the memory of Washington at Baltimore, have certainly a most imposing and gorgeous appearance, owing to the fineness and beauty of the material. But the buildings which are constructed of the blue or unselected marble, such, for example, as the State Capitol at Albany, (the new State Hall,) have a bloated and dingy look; and the general effect produced by the marbles in these buildings is greatly inferior to that of some of the sandstones from Craigleith and other British quarries." *Edinburgh New Philosophical Journal*, April, 1841.

The "dingy" appearance here spoken of, and which is particularly observable in the State Hall in damp or rainy weather, is owing to the want of care in the selection of the blocks, most of them being of a bluish tint, while others are white. Whatever difference of opinion there may be in regard to the relative beauty of different coloured marbles, uniformity should if possible be preserved. It is the want of this, rather than the colour, that injures the general effect of the building in question.

seams of other magnesian minerals which could not be polished, or were quite too friable to sustain the rough usage which is required for the dressing of marble.

To this notice of our marbles, I might add, that beds which at present seem to be of inferior importance for ornamental purposes, are found in the Counties of Albany, Saratoga, Schoharie, Seneca, Ulster and Wayne. In Albany, in the town of Coeymans, it is grey, and contains organic remains, but does not receive a good polish; in Saratoga, it is oolitic; in Schoharie, it is black, and is found in the towns of Esperance and Broome; in Ulster, it is black; and in Wayne, in the town of Sodus, it is a compact shell limestone, is used for ornamental purposes, and is similar to that found in Niagara county.

Such is a view of the principal depositories of marble in this State; and from this it is quite apparent, that both as it regards quantity and quality, our resources in this important article are ample. Its value to us is as yet scarcely appreciated.* Every coming year must serve to unfold it. The number of our public works, and the increasing attention to the beauty and durability of building materials, must operate as inducements to the proprietors of quarries to test the properties of the strata which they contain. Such is the nature of our climate, that it is perhaps of more consequence here than in any other country, that materials for important structures should be carefully examined, and such only be employed as are proof against those destructive agencies which are so incessantly in operation.

On this subject, the remarks of the late Secretary of State, the Hon. J. A. Dix, in his Report to the Legislature in 1836, are so much in point, that I must take the liberty of introducing them entire. "The importance," says he, "of ascertaining the mineralogical composition of rocks employed for building, may be readily understood by a reference to some of the circumstances attending the construction of the Rochester aqueduct, by which the Erie canal is carried over the waters of the Genesee river. When this work was in progress, a stone in the neighbourhood was quarried and dressed for some part of the exterior of the structure; but after being exposed to the action of the atmosphere for a short time, it was found to have literally crumbled to atoms. Another stone somewhat different was obtained, and after being subjected to some partial trials, it was selected for the arches and other parts of the work, in which a firm and durable material was indispensable. This structure is now so nearly in ruins in consequence of the disintegration of the stone, that contracts have already been made for reconstructing it. The material referred to is a porous sandstone; and it would not have been difficult to foresee, if its mineralogical structure had been critically investigated, the consequences which have ensued. In so severe a climate, water, insinuating itself into the interstices of the stone, must freeze, and force its particles asunder."

* According to the census returns of 1840, the value of granite, marble and other stone produced in this State, is $1,679,015; and the number of men employed, 3715.

TABLE

Showing the composition of various marbles and limestones found in the State of New-York, with the proportion of pure lime and magnesia which they contain.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Carbonate of lime,	60.50	75.65	44.65	98.50	99.30	93.50	53.24	61.75
Carbonate of magnesia,	39.50	20.70	30.00	-----	-----	-----	45.89	38.25
Silica and alumina,	-----	2.25	24.00	0.90	0.40	3.75	0.87	
Oxide of iron,	-----	0.35	1.00	0.35	0.20	-----	trace.	
Bituminous matter,	-----	-----	0.30					
Moisture and loss,	-----	1.05	-----	-----	-----	2.75		
Proportion of pure lime in 100 parts of the mineral,	34.14	42.69	25.19	55.58	56.03	52.76	30.04	35.04
Proportion of pure magnesia in 100 parts of the mineral,	19.12	10.03	14.54	-----	-----	-----	22.23	18.54

No. I. Dover, Dutchess county. White or bluish white; made up of small grains. Page 68.
II. Lockport, Niagara county. Greyish, compact; containing organic remains. Page 69.
III. Rochester, Monroe county. Calciferous slate of Eaton; gives out a bituminous odour when struck. Page 69.
IV. Chittenango falls, Madison county. Grey crinoidal limestone. Page 69.
V. Split Rock quarry, Onondaga county. Grey, and similar to the preceding. Page 69.
VI. Minischegongo creek, Rockland county. Dove-coloured, compact; has a conchoidal fracture. Page 70.
VII. Sing-Sing, Westchester county. White with dark spots, granular, and somewhat friable. Page 72.
VIII. Kane's quarry, Westchester county. White or bluish white, coarse grained, more compact than the preceding. Page 72.

Manufacture of Lime.

The minerals which have just been treated of, are also of great value in consequence of their use in the preparation of lime. Of this important article, the amount annually consumed in this State must be enormous. This amount, moreover, must constantly increase, in consequence of the new uses to which it is applied; as for example, in agriculture, the preparation of chloride of lime, &c.

The following remarks, from one of the Annual Reports of Dr. Charles T. Jackson on the Geology of the State of Maine, will serve to convey some idea of the value of this article:

"Few perhaps realize the fact," says he, "that there are no less than fourteen millions of dollars worth of limestone within twenty feet of the surface in Thomason; and that already, while but a trifling portion of the stone is exported, nearly half a million of dollars are annually realized from the sales of lime; besides which, we have also to estimate the value of the carrying trade, the whole business being in the hands of the citizens of Maine." "The lime," the same gentleman remarks, "serves to supply nearly all the cities on the Atlantic coast with the lime used in their buildings, and for agriculture."*

* *Second Report on the Geology of the State of Maine*, 1838.

It should be observed that a great improvement has been introduced into the process of burning lime, which consists in the use of refuse screenings or dust of anthracite for fuel, instead of wood, and the employment of the perpetual kiln. The coal dust is said to have cost $1.75 per ton in the city of New-York, while from fifty to seventy-five cents per ton were paid for its transportation to Thomason.

Here, then, we have the singular fact that fuel is transported from the city of New-York to Thomason, and the lime procured by its agency again brought to New-York. Now the lime thus obtained must be greatly superior to that which is produced from our limestones, or else our citizens have been strangely neglectful of their interests in this respect. I have reason to believe that the counties of Westchester, Putnam, Orange and Dutchess, contain limestones which would yield lime equal to any elsewhere manufactured. And with the improvements already introduced into our lime-kilns, as well as into those of Maine, one would suppose that our lime could be afforded at a much cheaper rate in the city of New-York, than that which is transported from a distant part of the United States. This subject commends itself to the enterprize of our fellow citizens.*

HYDRAULIC OR WATER LIMESTONE.

It is well known that the lime obtained by the calcination or burning of the different kinds of limestone differs greatly in its properties. When the limestone is pure, the resulting lime is also of uniform purity. Upon the addition of water to such lime, a high degree of heat is produced, its bulk is greatly increased, and it at length falls to powder. This powder, when mixed with water and a due proportion of sand, and afterwards exposed to the air, gradually acquires a stony hardness; but this result is not produced when the mixture is submitted to the action of water. Now these are designated by the name of *air limes;* and their relative value depends in some measure upon the kind of limestone, and the particular mode of calcination.

But certain impure limestones, when subjected to calcination, afford limes which, while they do not undergo much change by simple exposure to the air, do not slake when moistened with water, but when reduced to powder, absorb this liquid without producing much increase in volume, and without the evolution of much heat; and they moreover form with it a paste possessing little tenacity, and which, when placed under water, hardens after the lapse of a few days. These are now known by the name of *Hydraulic* or *Water Limes*. They differ much in the rapidity with which they harden under water, and in the degree of solidity which they ultimately attain.

There are still other limestones, which afford limes possessing the remarkable and very useful property of becoming hard almost instantly, like plaster of Paris, whether exposed to the air or in contact with water. These are sometimes called *Roman cements*. It should be

* According to the last census returns, the value of bricks and lime manufactured in the State was $1,213,326.

remarked, however, that the French generally employ the term *ciment*, to designate fine pounded bricks or tiles; while in this country, the term *cement* is most commonly used in a generic sense, and includes the hydraulic constituent of mortars, whatever that may be.

It must always be considered as a most fortunate circumstance, that so soon after the commencement of the Erie canal, a material was found in its immediate vicinity, which yielded a lime well suited for the construction of locks and aqueducts. It is worthy of inquiry, however, whether in these and in similar works since constructed, sufficient attention has been paid to the selection and preparation of the hydraulic limes thus employed.

There is still some difference of opinion as to which of the ingredients of these impure limestones the hydraulic property is to be ascribed. • Some of those who have examined the subject, have fixed upon the oxide of iron as the important ingredient; while the claims of the oxide of manganese, silica, alumina, magnesia, and even soda, have each been urged by respectable authority. It is, after all, however, more than probable that the hydraulic property is not due to a single ingredient, but belongs rather to several substances, or to a class of compounds.

It appears from the experiments of Berthier and Vicat, the highest authorities upon this subject, that no mixture, of which silica does not form a part, acquires hydraulic properties; that limes containing only silica or alumina, or better those containing silica and magnesia, acquire a much greater degree of hardness than the silicates of pure lime; and that the oxides of iron and manganese contribute nothing to the hardening of these bodies.

More recently, M. Vicat has asserted that magnesia alone, when in sufficient quantity, will render pure lime hydraulic. The proportions of magnesia which he recommends, are from thirty to forty parts of it weighed after calcination, to every forty of pure anhydrous lime. "M. Vicat also points out the importance of these observations: hydraulic lime never having been found in the calcareous formation below the lias, is because the dolomites have never been examined; but it is now probable that it may be found in this lower formation."*

It would be out of place in a Report of this kind, to enter fully into the consideration of this subject. Several important works have recently appeared in reference to it, which should be attentively studied by all who have the direction of aquatic structures. In France, where the arts of construction have for several years received such distinguished attention, much has been done towards establishing correct principles in regard to the preparation and mode of using hydraulic limes, cements and mortars. Valuable information will be found upon these points, in the extensive treatises of Dumas and Berthier, and in the able work of Vicat. Important service has also been rendered to the arts of construction in this country by Colonel Totten, who has translated and published in the Journal of the Franklin Institute for 1837 and 1838, a very excellent memoir on hydraulic and common mortars by General Treussart; and the same valuable periodical contains several other papers on those subjects, which may be advantageously consulted.

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* *London and Edinburgh Philosophical Magazine, etc.* Third Series, VIII. 591.

As the proper selection and management of hydraulic limes is a matter of vast importance, I trust I shall be excused for adverting to a few points, to which there is reason to fear that sufficient attention has not been heretofore paid in the construction of our public works.

1. It is agreed on all hands, that there is a great difference in the hydraulic limes obtained from different limestones; and that the value of each, and the proper mode of using it, can be determined only by experiment.

2. It is admitted, that in all cases, the process of burning or calcining the limestone requires great care. A limestone, very proper in other respects, gives, when the heat is urged too high, what is called a *dead lime*, in consequence of the partial fusion of the mass; whereas, when the calcination is effected at too low a temperature, the resulting lime is meagre, and not hydraulic.

3. Hydraulic lime should be used as soon as possible after calcination; and when kept for any time, it should be carefully protected from the action of the air. It has been ascertained that the hydraulic property of limes is much weakened by their being exposed to the air; and consequently, all other things being equal, recently prepared hydraulic lime is to be preferred for important structures, to that which has been for some time manufactured.

4. It is generally agreed that the rapidity with which hydraulic mortar hardens, and the ultimate degree of hardness which it acquires, depend greatly upon the proper proportions of lime and sand, their intimate incorporation, and the amount of water employed in their mixture. All these are points which must be settled by previous experiments.

The leading principle involved in the hardening of these hydraulic compounds seems to be, that certain earthy substances, and especially silica, combine with the lime to which the carbonate of lime in these hydraulic compounds is brought by calcination, and that the silicate thus formed is converted into a solid hydrate by combination with water. The *setting* of boiled plaster, when made into a paste with water, affords the best illustration of the kind of change which these hydraulic compounds undergo during the process of hardening in contact with water. The selection of the raw material, and the different steps of its preparation, must have in view the complete fulfilment of this necessary condition.

I shall now proceed to notice some of the most important localities of hydraulic limestones in this State, and give the results of the analyses made in reference to this subject.

Ulster County. Hydraulic limestone is found in great quantities in this county, and the manufacture of cement has for several years been quite extensively carried on. It is probably, however, still only in its infancy.

The beds of hydraulic limestone that yield the cement in this county, are situated in the vicinity of Kingston, Rosendale, Lawrenceville and High Falls. The mode of preparing the cement is sufficiently simple. The limestone is first reduced to small fragments, which are then thrown into a kiln, with layers of the screenings of anthracite intermixed. At an interval of twelve hours, the lower layers of the kiln are removed, and fresh portions of the limestone thrown into the upper part. These operations are so managed, that each layer is subjected to heat for about three days.

The lime thus calcined is of a light drab colour; and when reduced to powder, and mixed with about one third its bulk of sand and made into a paste with water, soon becomes hard. The grinding is performed in a mill, and the powdered cement is put up in barrels, which are lined with paper, to prevent as much as possible the access of air.

According to Mr. Mather, there were, during the year 1839, sixty kilns in this county for the manufacture of cement, and it was estimated that 600,000 barrels were manufactured during that year. It was used in the Croton Water-Works, shipped to various Atlantic ports, and to the West Indies.*

I analyzed a specimen of the hydraulic limestone from the vicinity of Rondout. It was of a bluish colour, with occasional grey and reddish spots. The texture was close and compact, and the fracture even and conchoidal. The following are the results:

Carbonic acid,	34.20
Lime,	25.50
Magnesia,	12.35
Silica,	15.37
Alumina,	9.13
Peroxide of iron,	2.25
Bituminous matter, moisture and loss,	1.20

The calcined cement contained only five per cent. of carbonic acid, and its composition may be thus expressed:

Carbonic acid,	5.00
Lime,	37.60
Magnesia,	16.65
Silica,	22.75
Alumina,	13.40
Peroxide of iron,	3.30
Loss,	1.30

By calcination, therefore, this limestone is reduced to a state approaching that of a double silicate and aluminate of lime and magnesia; and the theory of the hardening of this cement is sufficiently in accordance with the views above suggested. The cement, moreover, forms a jelly with muriatic acid, which still further proves that its chemical nature has been changed during the calcination.

An important practical inference from these experiments and observations is, that the more completely the carbonic acid is driven off from the limestone by calcination, without causing its fusion, the more energetic will be the resulting product. It is probable that a long continued, rather than a very high heat, will best effect this object.

It remains to be mentioned, that the limestone which overlies this cement has a blue colour,

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* *New-York Geological Reports*, 1840.

and a structure somewhat granular; it contains organic remains, and occasionally nodules of calcareous spar and sulphuret of zinc, with alternating layers or masses of hornstone. On analyzing a fragment of this rock, I found it to consist of carbonate of lime, with a minute portion of oxide of iron and bituminous matter, and with about eight per cent. of argil, or silica and alumina. It does not contain even a trace of magnesia, although so closely associated with the magnesian stratum above described.

Water limestones occur in Albany County, in the Helderberg;* in Montgomery County, about ten miles northwest of Schenectady, where it is of a drab colour, and resembles those found farther west; also in Herkimer County, some of which Mr. Vanuxem thinks would afford cements equal to any elsewhere made; while according to the same geologist, they are found in immense strata in Oneida County.†

Schoharie County. In the immediate vicinity of Schoharie Court-House is a stratum of hydraulic limestone, which, according to my analysis, has the following composition, viz:

Carbonic acid,	40.34
Lime,	31.75
Magnesia,	14.91
Silica and alumina,	11.50
Peroxide of iron,	1.50

So that it does not differ essentially from the specimens obtained in Ulster county and elsewhere. A remarkable fact connected with the water limestone of Schoharie, is the abundance of sulphate of barytes and carbonate of strontian which it contains. These will be noticed in the succeeding part of this work.

Madison County. The hydraulic limestone of this county has long been in high repute. One of the most important localities, and I believe one of the first, if not the very first, discovered in the State, is situated about a mile and a half southwest of the village of Chittenango. It has usually a drab colour, sometimes striped with reddish bands, a conchoidal fracture, an earthy texture, and is covered by layers of the calciferous slate of Eaton. The process of burning and grinding is similar to that heretofore described. When this cement is used in the construction of works, it is mixed with from two to three parts of sand.

It is computed that 100,000 bushels of hydraulic lime are annually sent from this town. The average price is fourteen cents a bushel, which therefore yields a return of $14,000.

The following are the results of two analyses of hydraulic limestone from this county; the first, by Mr. H. Seybert;‡ the second, by myself:

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* According to an analysis of Prof. Eaton, which, however, he did not deem very accurate, this limestone contains 25 per cent carbonic acid, 26 lime, 28 silica, 13 alumina and magnesia, 1 iron and 2 water. *Transactions of the Albany Institute.* Volume I. Appendix, 53.

† *New-York Geological Reports*, 1838.

‡ *Transactions of the American Philosophical Society*, New Series, II. 229.

	I.		II.
Carbonic acid,	39.33		38.65
Lime,	25.00		27.35
Magnesia,	17.83		16.70
Silica,	11.76		8.95
Alumina,	2.73		4.90
Peroxide of iron,	1.50		1.75
Moisture,	1.50	Moisture, bituminous matter and loss,	1.70

The composition of the calcined lime, in the state in which it is ordinarily used as a cement, is as follows:

Carbonic acid and moisture,	10.90
Lime,	39.50
Magnesia,	22.27
Silica,	16.56
Peroxide of iron and alumina,	10.77

The proportion of carbonic acid, however, depends entirely upon the manner in which the calcination is conducted, and it probably differs considerably in different specimens.

The blue fetid limestone which is associated with the water limestone is a nearly pure carbonate of lime, containing 0.70 per cent. of insoluble matter, and a trace of oxide of iron and bitumen, to which last is probably to be ascribed the odour which it gives out when struck with a hammer. It contains no magnesia.

I have also examined a specimen of the calciferous slate of Eaton, from the hill on the east side of the village of Chittenango. The results are as follows:

Carbonic acid,	40.95
Lime,	29.00
Magnesia,	17.30
Silica and alumina,	11.00
Peroxide of iron,	1.10
Moisture and loss,	0.65

This composition, which I have reason to believe is quite constant, will satisfactorily account for the occurrence of sulphate of magnesia or Epsom salt, which is so often found in efflorescences on this rock. It contains a sufficient amount of sulphuret of iron to furnish the acid for this decomposition.

Onondaga County. An important locality of water limestone occurs about a mile and a half west of Manlius. The overlying rock is a blue limestone, similar to that found at Chittenango. Some of the strata of water limestone are clouded or striped, while others are of a uniform grey or drab colour. Through the upper layers there passes a thin seam of white calcareous spar, in which are to be found small crystals of fluor of a dark purple colour.

The cement manufactured at this place was used in the construction of the aqueduct at Syracuse, and in that of several of the locks on the enlarged canal.

The water limestone from this quarry has the following composition :

Carbonic acid,	39.80
Lime,	25.24
Magnesia,	18.80
Silica and alumina,	13.50
Peroxide of iron,	1.25
Moisture and loss,	1.41

According to Mr. Hall, the formations from which water limestone has been selected, extend across Monroe County from east to west; the one through the towns of Penfield, Brighton, Gates, Ogden and Sweden; the other through Mendon, Rush and Wheatland. At one locality in Ogden, this limestone has been burned and used for cement in the locks of the Erie canal, and is said to have been of good quality. The same kind of stone may be found at the upper falls of the Genesee at Rochester.*

In Orleans County, some of the upper layers of the rock at the falls of Oak-orchard creek are used for the manufacture of water cement. A stratum of hydraulic limestone also occurs at Lockport in Niagara County, which has been used in the public works at that place; but some doubts have been entertained in regard to the goodness of the material.

Erie County. Water limestone has been found on Grand Island, and at Williamsville in this county. The specimens which I received have a dark drab colour, and the usual conchoidal fracture. The following are the results of their analysis—No. I. from Grand Island; No. II. from Williamsville :

	I.	II.
Carbonic acid,	41.01	37.66
Lime,	28.79	26.11
Magnesia,	17.70	16.48
Silica and alumina,	12.25	18.45
Bituminous matter, moisture, &c.	0.25	1.30

Finally, water limestone occurs near Depeauville in Jefferson County; and also near Waddington in St. Lawrence County, where it forms an extensive stratum. It is said that the value of the water lime annually manufactured in the latter county is $40,000.†

Such are some of the more important localities of this valuable mineral product. The number of these will no doubt hereafter be much increased; and perhaps many quarries, now little valued, will be found upon examination and trial to furnish cements equal to those at present so generally employed.

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* *New-York Geological Reports*, 1838.

† *Report of the St. Lawrence Railroad Committee.* December, 1838.

I cannot refrain from again calling the attention of the public to this subject, as one of more than ordinary importance. When it is recollected that the durability and strength of many of our public works depend upon the water cement employed, it must be a matter of deep interest to those who are entrusted with their superintendence. The water lime now used, being procured from various localities and manufactured in various ways, cannot possess an uniform character. Furnished as it is at different points on the canal route by contract, it requires more than ordinary care and skill to ascertain the fitness of the several parcels for the works in which they are to be employed. After maturely considering the subject in all its bearings, it appears to me that the only way in which the objections to the present mode can be obviated, and an article of uniform purity obtained, is by having the quarrying of the water limestone, and the process of its conversion into lime, conducted under the direction of the agents of the State; when the different parcels even thus produced should be constantly subjected to the severest trials, before being used in any important structures. It is true that the expense of the article might be thus somewhat increased, but this would be trifling in comparison with the advantages which would be secured. For it should be distinctly observed, that while a good water lime is invaluable in the construction of locks, a poor one is worse than useless. The State of New-York is at present, and must be for years to come, so deeply interested in this matter, that I cannot hesitate to urge some modification of the present plan upon those who are charged with the direction of her public works.

TABLE

Showing the composition of various specimens of Hydraulic Limestones and Cements, from the State of New-York.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Carbonic acid,	34·20	5·00	25·00	40·34	39·33	38·65	& moist. 10·90	40·95	39·80	41·01	37·66
Lime,	25·50	37·60	26·00	31·75	25·00	27·35	39·50	29·00	25·24	28·79	26·11
Magnesia,	12·35	16·65	.....	14·91	17·83	16·70	22·27	17·30	18·80	17·70	16·48
Silica,	15·37	22·75	28·00		11·76	8·95	16·56				
Alumina,	9·13	13·40	& mag. 18·00	11·50	2·73	4·90	10·77	11·00	13·50	12·25	18·45
Peroxide of iron,	2·25	3·30	1·00	1·50	1·50	1·75		1·50	1·25		
Bituminous matter,	1·20	loss, 1·30	water, 2·00	.....	moisture 1·50	1·70	.....	.....	.....	0·25	1·30
Moisture and loss,				.....			.....	0·65	1·41		

No. I. From the vicinity of Rondout, Ulster county. Texture close and compact; colour bluish, with grey and red spots. Page 78.

II. Calcined cement from the preceding locality. Page 78.

III. From the Helderberg, in Albany county. The analysis by Prof. Eaton. Page 79.

IV. From the immediate vicinity of Schoharie Court-House. Colour drab, resembling the next. Page 79.

V. Madison county, particular locality unknown, but probably from the vicinity of Chittenango. Analysis by Mr. H. Seybert. Page 80.

VI. From the vicinity of Chittenango, Madison county. Colour drab, with reddish bands; fracture conchoidal; texture earthy. Page 80.

VII Calcined cement from the preceding locality. Page 80.

VIII. Calciferous slate of Eaton, from the hill east of the village of Chittenango, Madison county. Page 80.

IX. From the quarry a mile and a half west of Manlius, Onondaga county. External characters similar to the specimens from Chittenango. Page 81.

X. From Grand Island, Erie county. Colour dark drab; fracture conchoidal. Page 81.

XI. From Williamsville, Erie county. Resembles the preceding. Page 81.

MARL.

Description. This substance is arranged by Cleaveland as a sub-species of carbonate of lime, of which indeed it is essentially composed. Some marls are more or less indurated, while others are friable and earthy. In some the argillaceous ingredient is comparatively small; in others, again, it abounds, and furnishes the predominant characters. The calcareous and argillaceous marls unite by imperceptible degrees, and the latter sometimes pass into clay. Marls, therefore, are sometimes arranged under the heads of calcareous and argillaceous, and sometimes under those of the indurated and the earthy.

The term *fresh water marl* is applied to those accumulations which have been formed by the decay of successive generations of shells at the bottoms of lakes or ponds. In marshes that were once ponds, the marl is often covered by a deposit of peat, arising from the growth and decay of plants.

The marls usually disintegrate or crumble by exposure to the atmosphere for a longer or shorter period, depending upon their nature. The same changes generally take place in a very short time when marl is immersed in water, with which it forms a short paste. It is probably to these properties that this substance owes its value as a manure.

Composition. All marls effervesce with acids, sometimes very briskly and sometimes feebly, according to their solidity and the proportion of carbonate of lime, which may vary from twenty-five to eighty per cent.; indeed in the argillaceous marls it is often much less.*

To ascertain the proportions of the ingredients of a marl, a known weight of it may be treated with dilute muriatic acid, by which the calcareous part will be dissolved; and the residue, being dried and weighed, will give the amount of clay with sufficient accuracy to lead to correct conclusions in regard to its use as a fertilizing agent.†

There are in this State many rich and extensive localities of marl, but their value does not appear to be appreciated. The following are more particularly deserving of notice.

Albany County. In the towns of Bethlehem and Coeymans in this county, there are beds of marl of some extent, which contain from forty to eighty-five per cent. of carbonate of lime. They have not, however, it is believed, been much used for agricultural purposes.

Cayuga County. According to Mr. Hall, the Cayuga marshes, which embrace an area of forty thousand acres, are in many, and probably in all places, underlaid by marl to the depth

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* Cleaveland. *Elementary Treatise on Mineralogy and Geology.*

† According to Chaptal, "Marl is principally composed of sub-carbonate of lime and alumina; the proportions in which these are combined constitute all its varieties. The lime contained in marl, as it is taken from the bed, is never saturated with carbonic acid; but after being exposed to the air, it becomes at length saturated with the acid it receives from it, crumbles and effloresces. The decomposition of marl may be hastened by frequently turning it, so as to allow the air free access to the lime; and this method is generally practised by those who employ marl as a manure." *Chemistry applied to Agriculture.* Amer. Ed. p. 44.

of several feet.* Should these marshes be drained, they will furnish an enormous quantity of the richest manure.

Cattaraugus County. There are several beds of tufa and marl in this county. The largest heretofore discovered is about two miles southeast of the village of Lodi, on a branch of the Cattaraugus creek. Several thousand bushels of lime have annually been obtained from this bed. Another locality of marl occurs in the eastern part of Otto, which has been worked for some years. To these several others may be added, and it is supposed that there is a sufficient abundance of marl and tufa in this county to furnish immediately 300,000 bushels of lime.†

Chautauque County. Large deposits of shell marl are found in Cassadaga lake, and the marshes which nearly divide it into two portions. In consequence of the scarcity of limestone, it has long been used for burning into lime. It is made into the form of bricks, and then burned. About two thousand bushels of lime are thus annually manufactured.

Chemung County. There are extensive beds of shell marl at the Beaverdam in the town of Dix, and near Horseheads; and as is the case in Chautauque county, it is cut into blocks, and then dried and burned into lime. Near Millport, also, it is said that there exist abundant deposits of marl; and Mr. Hall states, that in that vicinity, the water flowing through the soil, and rising from springs, is so highly impregnated with lime,‡ that on standing a few hours while the carbonic acid escapes, a thin deposit of calcareous matter is observed.‖

Columbia County. The deposits of marl are perhaps as abundant in this county as in any other in the State. They occur in Lebanon, Kinderhook, Hillsdale, Canaan and Copake. At some of these localities, shell marl is in the process of formation at the present time. Mr. Mather estimates that there are 100,000 cart loads of marl in Peat Marl Pond, about four miles north of Kinderhook. When it is recollected that a large quantity of gypsum is annually consumed in this county as a manure, it is certainly remarkable that an article which can in most cases be employed with equal advantage, should be almost entirely neglected. It cannot be doubted, however, that its value will soon be duly appreciated.

Cortland County. There are three marl ponds a short distance west of Cortlandville, covering an area of about twenty-five acres. Several small ones occur in the northern part of the county. In the vicinity of Cortlandville, large quantities are annually used for burning into lime. Still the deposits seem to be gradually increasing.§ The marl usually abounds in shells.

Dutchess County. In this as well as the neighbouring county (Columbia), the deposits of marl are numerous and abundant. They have been noticed in the towns of Rhinebeck,

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* *New-York Geological Reports*, 1839.

† Horsford. *New-York Geological Reports*. 1840.

‡ Undoubtedly in the form of a soluble bicarbonate of lime.

‖ *New-York Geological Reports*, 1839.

§ Vanuxem. *New-York Geological Reports*, 1840.

Northeast, Pine-Plains, Stanford, Redhook and Milan. They are often associated with peat. In some cases the stratum of peat is three or four feet in depth; this is succeeded by a stratum of peat and marl from three to four feet; and lastly, by a stratum of pure marl of two or three feet. The beds of marl in this county are mostly made up of shells.

Genesee County. There are several deposits of marl in the vicinity of Batavia. There are also extensive marl swamps in the neighbourhood of Le Roy.

Greene County. The towns of Catskill and Coxsackie contain beds of rich marl. A specimen from the latter has a white colour, is very friable when dry, and is nearly a pure carbonate of lime. The following are the results of the analyses of two samples—No. I. being from the farm of Mr. Van Bergen, near Coxsackie; No. II. from the vicinity of Catskill:

	I.	II.
Carbonate of lime,	97.32	91.75
Insoluble matters (principally silica and alumina),	2.15	8.25
Oxide of iron, with vegetable matter,	0.53	trace.

Madison County. This county contains many valuable localities of marl. There is a bed of it near the village of Chittenango; and Mr. Vanuxem informs us that the Cowasalon swamp, which contains about ten thousand acres, is a vast accumulation of marl, of unascertained depth.* Besides this, most of the ponds in this county have bottoms of the same substance.

Monroe County. Rich deposits of marl occur in this county, especially in the towns of Riga and Wheatland. In the latter of these is a very extensive deposit, which in some portions is almost pure carbonate of lime, containing an abundance of shells; in other places, it is mixed with earthy matter. This deposit is three miles in length, and extends into Livingston county. In Riga, the marl is of sufficient purity to be burned into lime.

In Montgomery County, earthy marl occurs abundantly near Canajoharie, Fort-Plain and Fonda.

Niagara County. Between the mountain and lake ridges, shell marl is an abundant product; and the same remark applies to the region along the Tonawanda creek, in the southern part of this county. In a swamp five miles east of Lockport, there is an extensive deposit. It has not yet been used there for agricultural purposes.

In Oneida County, peat and marl occur in the town of Clinton; and in Otsego County, deposits of marl are found in the southern part of the town of Cherry-Valley, where it is deposited by streams flowing through a drab limestone. There are several similar deposits in the northern part of the latter county.

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* *New-York Geological Reports*, 1839.

Onondaga County. There are few counties in which this substance is more abundant than in Onondaga. The great swamp, which is a prolongation of the Cowasalon, contains a deposit of marl. The bed of the Onondaga lake also consists of marl, which has been precipitated from the waters, and contains myriads of shells, which live in the lake and its tributary streams; and there are abundant deposits of the same substance all around the villages of Salina and Syracuse. Another is found in the northern part of Tully; and it is remarked by Mr. Vanuxem, that all the small ponds in the southern part of this county contain marl.

Some years since, I analyzed a specimen of marl from the vicinity of Salina. It was found to be composed of

Carbonate of lime,	83.00
Silica,	10.00
Alumina,	7.00

Ontario County. There are several beds of marl south of Naples, and near the head of Canandaigua lake, in this county. So also in the northern part, there are numerous and extensive deposits of the same substance. Along the valley of Flint creek there is, according to Mr. Hall, a deposit of lake marl extending for several miles in length, and from half a mile to a mile in width.*

Orange County. This county, like the last, is rich in beds of marl. It is supposed to exist in every town in the county. It either lies naked, or is covered by bog earth and peat, and its presence can be determined with the greatest ease. Some specimens contain a large proportion of carbonate of lime, and might be used for burning into lime. It has not yet been much employed for agricultural purposes.

A specimen of marl from the lands of Gen. Wickam had the following composition:

Carbonate of lime,	93.75
Silica and alumina,	6.25

It is worthy of notice, that some of the beds of marl in this county contain fossil bones.

Orleans County. One mile south of Holley, and two and a half miles north of Medina, are the localities of marl which have been noticed in this county. The mineral at both these places is highly calcareous, and at the former is said to contain abundance of shells; but it is not thought to be abundant.

There is a locality of marl in the town of Sandlake, in Rensselaer County. In the town of Schaghticoke there occurs a kind of schistose marl or argillaceous limestone, which contains thirty or forty per cent. of carbonate of lime, and which would be very valuable for agricultural purposes.

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* *New-York Geological Reports*, 1839.

St. Lawrence County. We are informed by Dr. Emmons, that there is a deposit of fresh water marl, containing shells, in the town of Edwards. Its location is among the granitic and limestone mountains of this region, upon the soil of which this marl would be highly beneficial.*

Saratoga County. It is stated that marl underlies almost the whole sandy alluvion which is here so widely diffused. In Schoharie County, although I am not aware that any deposits of marl have been made known, there is abundance of calcareous tufa, and a friable agaric mineral, which might be advantageously employed for the same purposes. The agaric mineral has the following composition:

Carbonate of lime,	97.25
Silica,	0.80
Organic matter,	1.95

It would answer well for burning into lime.

Seneca County. Several beds of marl have been found in this county. One of these is in the north part of Varick; and there are several near the village of Ovid. It has been used here to a limited extent, both for burning into lime, and for agricultural purposes.

In Steuben County, about four miles north of Bath, there is an extensive deposit of marl and tufa, the results of repeated depositions from a copious spring. The marl is said to be largely mixed with clay, but it is thought to be sufficiently pure for agricultural purposes.

Tioga County contains at least one bed of marl, at the bottom of a pond in the town of Spencer.

Tompkins County. Several valuable deposits of this mineral are already here made known. Thus there is a very extensive one in the southern part of Hector, which embraces an area of six acres; also at Reynoldsville there are several beds, from one of which two thousand bushels of lime are burned annually.† Again, there are several beds on the land of Mr. A. Wood, six miles from Ithaca, and others occur near Newfield.

There are several localities of marl in Ulster County. Some of them contain fossil bones. The following are the results of an analysis of a specimen from the neighbourhood of the village of Kingston, viz:

Carbonate of lime,	92.75
Silica and alumina,	3.25
Vegetable matter,	4.00

It perhaps should be stated here, that there is in the vicinity of the High falls a soft argillaceous limestone, which, as it may be easily reduced to powder, has been proposed as a

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* *New-York Geological Reports*, 1837.

† Hall. *New-York Geological Reports*, 1839.

fertilizing agent. Its composition is similar to that of the water limestone so abundant in this county, and with which it is no doubt associated. An analysis gave the following results :

Carbonate of lime,	29.45
Carbonate of magnesia,	24.30
Silica and alumina,	42.50
Oxide of iron,	3.75

This limestone contains cubical and dodecahedral crystals of iron pyrites, similar to those found in the county of Schoharie.

Warren County. The northern parts of the State are known to be less abundantly supplied with marl than the southern or western parts. They contain, however, a few localities of this kind. And in addition to those already noticed, we have an extensive deposit in the town of Queensbury in this county, on lands owned by Mr. Jenkins, and there are several smaller ones in that vicinity; the marl being generally associated with peat.

In Washington County, a white and friable marl, resembling the whiting of commerce, has been found.

Wayne County. A white and earthy marl, containing abundance of shells, is found underlying the Cayuga marshes in the town of Savannah. Again, along the Erie canal, near Newark, is a deposit of a similar kind, but of no great depth. Another occurs at Cooper's swamp, in the south part of the town of Williamson; while of the gypseous marl, or the mixture of marl and gypsum, there are several localities in this county.

From the preceding facts, it is evident that the State of New-York is abundantly supplied with the mineral just noticed. Other localities will undoubtedly be added to the list, as soon as its great value for the purposes of agriculture come to be properly understood. It is well known, that in some parts of the United States, marl has been used with the most beneficial results. It should be remarked, however, that this term is often widely applied to include almost all fertilizing agents applied to the soil. Thus the New-Jersey marls, which have effected such an astonishing change in the agricultural condition of that State, belong to what is called the "green sand" formation, and contain but a small proportion of carbonate of lime, which predominates in almost all the New-York marls. It is supposed that the potash is the chief fertilizing ingredient in the New-Jersey marls; while there can be no doubt that carbonate of lime is the constituent which gives to the shell marls, to which those of New-York principally belong, their value.

It may be added, on the authority of a standard author on this subject, that shell marl may be used at the rate of from twenty to thirty cart loads to the acre; while of the clay marl, a much larger amount may be employed. These proportions, however, must depend in a great measure upon the nature of the soil to which it is to be applied.*

* Chaptal. *Chemistry applied to Agriculture.* Amer. Ed. 44.

SOILS.

Having now completed my account of the various mineral substances usually employed in Agriculture, I propose to annex to it a brief and general view of the soils of the State, chiefly in reference to their chemical composition.

The soil, as it is well known, is a mixture of various mineral substances, with small proportions of animal and vegetable matters, usually in the process of decomposition. The mineral parts of the soil are composed of the same substances which constitute the mountain rocks and mineral masses which are found on the earth, and form its crust or covering. These rocks are broken down by degrees, and are decomposed by the influence of air and moisture.

Now all the rocks and other mineral masses which exist on the surface of the earth are found to consist of a few bodies, the principal of which are the following, viz. silica, alumina, lime, magnesia, oxide of iron, soda and potassa.

The following classification of soils, which is sufficiently particular for my present purpose, is that proposed in a recent standard work on agriculture.*

1. *Siliceous* or *Sandy Soils.* In these, silica or sand predominates. This earth is very widely diffused, being found in quartz, of course entering largely into the composition of granite, and also existing in various silicates, as serpentine, tremolite, diallage, hornblende, &c.

2. *Aluminous Soils.* These contain a large proportion of clay, the basis of which, alumine, is, next to silica, the most generally diffused. Indeed, in combination with silica, it forms a great proportion of all the rocks and mineral masses on the earth.

3. *Calcareous Soils.* Those in which carbonate of lime predominates, and which are the result of the breaking down of the different forms of carbonate of lime, or of the various limestones which exist so abundantly in all parts of the world.

4. *Magnesian Soils.* Those in which magnesia, in various states of combination, constitutes an ingredient.

5. *Ferruginous Soils.* Those soils in which the oxide of iron is contained in considerable proportion.

The soils of this State are as diversified as those of any other territory of equal extent. There are to be found here examples of all those varieties which have been described by standard authors on Agriculture. It is important to notice these, at least in a general way; as the nature of the soil determines the kind and quantity of manure which may be employed in order to increase its productiveness.

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* *Elements of Practical Agriculture, &c.* By David Low, Esq. F.R.S.E. Professor of Agriculture in the University of Edinburgh. — This work was republished in the Rural Library, by S. Fleet, in 1839, with alterations and additions adapted to the climate and peculiarities of the United States.

The *Siliceous* or *Sandy Soil* is widely diffused throughout the State of New-York; much more so, indeed, than might at first be supposed. It is found in many parts of Long Island, of Westchester county, of Staten Island, York Island, and of the counties of Columbia, Albany, Schenectady, Montgomery, Saratoga, Washington, Warren, Essex, Lewis, Clinton, Franklin, Jefferson and St. Lawrence. The northern part of the State is as strongly characterized by the large tracts covered by sand, so far as its soil is concerned, as by almost any other physical character. The siliceous soil is, moreover, perhaps less deeply covered with vegetable matter than it is in other parts of the State; a circumstance worthy of attention in the attempts which may hereafter be made to increase its fertility. The fact itself may be owing to the greater proportion of silica in the rocks from which this soil is derived.*

The *Aluminous* or *Clay Soil* characterizes tracts in this State almost too numerous and extensive to be particularly designated. It abounds in most of the counties bordering on the Hudson; it is also found in many of the southwestern counties, and in some of the northern ones. This soil seems to have originated principally from the breaking down of greywackes, slates and shales; and the occurrence of these rocks is generally a token of the existence of the aluminous soil in the vicinity. When properly ameliorated, it is highly productive; although it also presents some difficulties which the agriculturalist is called upon to overcome.

Of the *Calcareous Soil*, the most extensive localities are those which occur in the western parts of the State; and no better evidence is required of the value of lime as a manure, than the proverbial fertility of this favoured region. This soil, in its natural state, contains small proportions of carbonate of lime, resulting from the pulverized fragments of limestone and tufa with which the western counties are so abundantly supplied. The great quantities of marl and gypsum which are there found, no doubt also contribute to the productiveness of the soil. These deposits of carbonate and sulphate of lime, often occupying the summits and slopes of the hills, by the agency of rain, yield their fertilizing and renovating influence to the valleys. Under such circumstances, water is no less certain in its effects than it is in the valleys of the Nile, the Ohio and the Mississippi.

It is somewhat remarkable that none of our supposed calcareous soils contain so large a proportion of carbonate of lime as many of the foreign ones. Bergman found, in one of the most fertile soils of Sweden, thirty parts of carbonate of lime in the hundred. A fertile soil from the neighbourhood of Turin, gave Giobert from five to twelve per cent. of carbonate of lime. A soil from the alluvions of the Loire contained, according to the analysis of Chaptal, nineteen per cent. of the calcareous carbonate.† But according to Dr. Charles T. Jackson, the proportion of carbonate of lime in the soils of Maine does not in any case exceed five per cent.‡ Prof. Eaton states that the soils of Rensselaer county are sometimes entirely destitute of carbonate of lime; and that the highest proportion which any of them contain, is five and

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* This suggestion was made by Dr. Horton, to whom I am indebted for much assistance in the preparation of the sketch of our soils which is here presented.

† Chaptal. *Chemistry applied to Agriculture.*

‡ *Third Annual Report of the Geology of Maine.*

a half per cent.* Prof. Hitchcock remarks, that the results of his experiments disclosed the remarkable fact, "that out of one hundred and twenty-five specimens of soils from all parts of the State (Massachusetts), and several of them from limestone tracts, only seven exhibited any effervescence; and even these, when analyzed, yielded but a small per cent. of carbonate of lime." He also adds, that a similar deficiency of calcareous matter exists, according to E. Ruffin, Esq. in the soils of Virginia; and the latter author makes a similar statement concerning the soils of some of the Western States, even in limestone regions. "I have," says he, "recently examined five of some of the richest soils of Ohio and Illinois; and although I find calcareous matter in all but one, yet the average quantity is not over two per cent. Hence I apprehend that we shall find a deficiency of carbonate of lime to be quite characteristic of a large part of the soils of this country. This could not always have been the case, especially in limestone regions;† and hence we learn—what indeed agricultural chemists now generally admit—that in cultivated fields, calcareous matter is gradually changed or consumed; and hence too we learn what is one of the great desiderata of the soils of Massachusetts."‡

If the foreign soils, of which the analyses are given above, were artificial ones, as is most probable, and if the statements in regard to our own soils are correct, there can be no doubt that the addition of proportions of carbonate of lime, much larger than have been usually employed here, would be eminently beneficial. This addition may be made either in the form of marl, powdered tufa, or of calcined lime now so generally used in Pennsylvania and New-Jersey.

In attentively considering the causes of the fertility of the western soils, one or two inferences are forced upon us. The first is, that if this fertility is derived either entirely or principally from the calcareous matters, there must be some peculiarity in the limestones and other forms of carbonate of lime which are there found. For it is certain that although there are extensive limestone ranges in the northern and southern parts of the State, the soils in their vicinity do not, on the whole, possess those characters which so strongly characterize the western soils. I have thought that this difference might arise from the difference in the state of aggregation or division of the various limestones and calcareous matters. It is well known that the fertility of soils depends, in a good degree, upon the ingredients which comprise them being in a state of minute division. Now this condition appears to be more fully attained in those limestones which belong to the transition or secondary classes, and especially in those which contain a certain proportion of clay. Indeed, the frequent occurrence of calcareous tufa in the western counties seems to be a sufficient evidence of the ease with which the western limestones are dissolved by water, and consequently of the minute state of division of which its particles are susceptible by ordinary atmospheric agencies.

On the contrary, those limestones which belong to the primary class possess a highly cry-

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* *Geological Survey of Rensselaer County.*

† Lime disappears from soils by being changed into a bicarbonate, in which form it is soluble. It is remarked by M. De Gasparin, who has written an interesting paper on soils, that the enclosure of *la grand Chartreuse*, which is formed of the debris of rocks which contain lime, does not now furnish a single particle of this earth.

‡ *Report of a Re-examination of the Economical Geology of Massachusetts*, 1838.

stalline structure, and disintegrate into grains which often have the appearance of coarse sand, and which indeed in some cases are more or less mixed with siliceous particles. Such are the dolomitic limestones of the counties of Westchester, Putnam, Dutchess, Jefferson, Franklin and St. Lawrence. Not unfrequently patches of this sandy or granular limestone are entirely destitute of vegetation; a circumstance which is, I think, to be chiefly ascribed to the mechanical constitution of the materials which compose them.

Another important conclusion to be drawn from the facts stated in regard to the western soils is, that magnesia in the mild or carbonate state, when mixed with carbonate of lime, exerts a beneficial rather than a deleterious influence. It was long since stated by Mr. Tennant, that a lime which contained magnesia was injurious to vegetation; and he also ascertained by experiment, that seeds sown upon a soil mixed with some calcined magnesia, either died or vegetated in a very imperfect manner, and that the plants were never healthy. Hence a prejudice soon arose against all magnesian limestones; and it was thought by many agriculturalists that this earth, in whatever form it was applied to the soil, must prove injurious to it.

Davy, in his Agricultural Chemistry, has placed this subject in its true light; for while he admits the correctness of Mr. Tennant's opinions, he at the same time gives reasons which induce him to believe that magnesian limestone, or carbonate of magnesia, is a fertilizing agent. Thus he observes that one of the most fertile districts in Cornwall, the Lizard, is one in which the soil contains carbonate of magnesia. The correctness of this observation has been confirmed by Prof. Giobert, who has announced that this earth is abundant in the most fruitful soils in the vicinity of Castelmonte, and that there are numerous localities of a similar kind in Piedmont. So also M. De Gasparin, in his memoir on soils, states that the carbonate of magnesia is contained in great quantities in the soils of the valley of the Nile; while, according to the same author, those of Bas Languedoc often furnish from eight to thirty-three per cent.*

Now carbonate of magnesia is a constituent of many of the western rocks, and must have entered largely into the composition of the soils which cover them. It exists in the proportion of twenty-five to thirty per cent. in the limestones of Rochester, Monroe county, and in those of Lockport in the county of Niagara. It is also found in the calciferous slate of Chittenango, and in all the water limestones which I have examined,† whether from Madison, Onondaga or Erie counties. Now the soils in the immediate vicinity of these magnesian rocks, so far from being sterile, are among the most fertile in the State.

If the above facts are to be relied on, we shall probably have the means of arriving at some certain results in regard to the action of magnesia upon soils, whether it be applied to them in the natural state as a carbonate, or in that state of causticity to which this is brought by the ordinary process of lime-burning.

The following are suggested as being thus deducible :

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* *Edinburgh New Philosophical Journal*, XXVII. 84.

† See the Tables showing the composition of several of our common and hydraulic limestones, pages 74 and 82.

1. Magnesian limestones are not necessarily injurious to vegetation; on the contrary, they may contribute to the fertility of soils.

2. Magnesian limestones belonging to the class of dolomites, as those of the counties of Westchester, Dutchess, Putnam, &c. often injure vegetation, or impair the fertility of the soil, in consequence of that peculiarity in their structure by which they seem to resist the action of those agents which reduce many other limestones to a state of minute division.

3. A lime containing magnesia may prove injurious if it be used within a short time after it has been burned; but if, after calcination, it is exposed to the air so as to allow the magnesia to be carbonated, it may then be employed with advantage in those cases where lime is indicated.

In addition to the magnesian soils arising from the decomposition of magnesian limestones, we have also a magnesian soil produced by the breaking down of the serpentine and steatitic rocks which are found in various parts of the State. Richmond, Westchester, Putnam, Jefferson and St. Lawrence counties may be particularly mentioned as examples. And it is worthy of remark, as corroborating what has already been said concerning the influence of magnesia upon vegetation, that the soils upon the sides and bases of these serpentine ridges are equal in fertility to any found elsewhere.

Although the ores of iron are very abundant in this State, what may be strictly termed *Ferruginous Soils* are not of common occurrence. This arises from the fact that the largest proportion of our ores are deposited in some rocky matrix, and hence they cannot be so easily reduced to that state of division which is necessary for their incorporation with the soil. Ferruginous soils are often found near the beds of hematite in Dutchess county, and also in those parts of Richmond, Westchester, Orange, and some of the northern and western counties where either bog iron ore or the lenticular iron ore abounds. It is not probable, however, that the oxide of iron, in the proportion in which it exists in these soils, produces any decided effects either beneficial or injurious.

It is hardly necessary to remark, that soils are seldom characterized in so marked a manner as the above classification would seem to imply. They are mixed in various proportions, and in some cases it is not easy to determine to which of the classes they belong. Moreover, the nature of these soils is continually undergoing changes, in consequence of the various modes of culture to which they are subjected. This renders it exceedingly difficult to present analyses of soils which shall be of practical utility.

COMBUSTIBLE MINERALS.

Under this head I include certain substances, not gaseous, which either burn with ordinary degrees of heat, and are employed as fuel, or which agree in their general chemical properties.

SULPHUR.

This well-known mineral, so useful in many of the arts, although for the most part confined to volcanic countries, has nevertheless been found in the State of New-York. It occurs in a pure form, but in small quantity, in a granitic rock near West Point; and a few miles west of that place, it has been found in a quartz rock. Small masses are also occasionally met with in the gypsum beds of the western counties. The best specimens which I have seen, are from Thomson's quarry in the county of Cayuga. The same mineral is not unfrequently deposited in nearly a pure form by waters charged with sulphuretted hydrogen gas.

In a state of combination, sulphur occurs abundantly in various parts of the State; as with iron, copper, zinc and lead, constituting sulphurets of these metals. Should it hereafter be necessary, these ores may be advantageously employed in the production of sulphur. It may be remarked in confirmation of this statement, that since the increase of the duty upon the Sicilian sulphur, the English have directed their attention to the procuring of sulphur from these ores. The result is, that it is confidently anticipated that they will not only thus obtain an abundant supply for their own consumption, but that it will become an article of export. The process, which is sufficiently simple, consists essentially in subjecting the sulphurets to heat, so as to disengage the sulphur; for the collection and purification of which, various arrangements of apparatus are employed.

ANTHRACITE AND COAL.

There are many localities of these important minerals in this State, which will be noticed in the Second Part of this Report. Unfortunately they have not hitherto been found in quantities sufficient for any useful purpose. Although large sums have been expended in researches for these minerals, and high expectations in some instances excited, they occur only in thin layers, and in geological relations which differ entirely from those of the true coal measures. The only substitute for coals in this State at present known, is the substance to be next noticed.

PEAT.

Description. This substance, also known by the name of *Turf*, has a loose texture, often porous or even spongy. When recently dug, it forms a viscid slimy mass, which, by exposure to the air, becomes dry, hard, and more or less light and brittle. Its colour is brown, sometimes yellowish or reddish, or a dull black.

Peat consists essentially of vegetable matter in various states of decomposition; but it is more or less mixed with saline and earthy substances. It burns with different degrees of ease, but sufficiently well to be employed as fuel. It gives out a bituminous odour, and leaves an abundant residue of light ashes, which, however, is sometimes largely mixed with earthy matters.

Peat is usually associated with marl, and its localities are almost as numerous as are those of that mineral.* From its great abundance, it will undoubtedly, at no distant period, be as extensively employed here as it now is in other countries. In many of our manufactories, it might be used with great advantage; as, for example, in the burning of bricks, of limestone, &c. It may also become valuable as a manure.

Chemical composition. The weight of a cubic foot of peat varies from forty-four to seventy pounds, the denser variety yielding about forty per cent. of charcoal. According to Sir H. Davy, one hundred parts of dry peat contain from sixty to ninety-nine parts of matter destructible by fire; and the residuum consists of earthy substances, usually of the same kinds as the substratum, as clay, marl, &c.

The method of procuring and preparing this article for use, is sufficiently simple. The beds of peat are almost always superficial, and on that account may be easily worked. The upper part, which is very fibrous, and is composed of a network of vegetable matters very distinct, is readily distinguishable from the lower part, which is compact, and formed of vegetables almost wholly decomposed, or without any apparent organic structure. Of these the latter is most highly valued. It is removed by a spade, and when of proper consistence, is moulded into the form of large bricks, and then dried by exposure to the sun and air. Sometimes machinery is employed for this purpose.†

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* For several New-York localities of peat, the reader is referred to the article on marl, page 83.

† It may be useful to give a particular description of the process of turf-digging, as it is practised in Ireland. "The turf-spade, in shape, is not unlike that used by gardeners in general; but it is lighter and narrower. With this implement, the workman first cuts away, in a sort of large cubical sods, the superior turfy stratum of the bog: as this is comparatively loose and light, it is presently dried and ready for use. On digging lower, the substance of the peat becomes more moist and compact, and appears more like rotten wood than the roots of moss; it has, however, a sufficient degree of fibrous connexion to admit of its being readily raised in masses somewhat resembling large bricks. These quadrangular clods, which the digger cuts out and throws up with great dexterity, are heaped in small stacks to dry; after which, they are either used on the spot, or carted away by purchasers, according to circumstances: to preserve them through the winter, the piles are sometimes thatched. On sinking still lower in the bog, the matter becomes less solid, loses its coherency, and assumes the consistency of black sludge; this is laded out with a scoop, similar to that used by brickmakers for wetting their clay, and is thrown upon a smooth floor or bottom, where, from expo-

It has been supposed by some that peat is constantly renewed; by others, this has been doubted. It is evidently the result of some change in the layers of vegetables deposited after their death, at the bottom of marshes or lakes, where they are mixed with mud and the remains of aquatic plants. But the fact that peat is not found in all marshes, leads us to suppose that its formation is due to some peculiarity in the vegetables, or in the circumstances attending their decomposition. Hence the opinion which has been entertained, that peat has been formed under conditions which do not now exist.

Peat is employed as a combustible in many parts of Europe. In Great Britain, its use as an economical fuel is very general where it abounds, but more particularly in Scotland and Ireland; one tenth of the latter being supposed to be covered with bog matter. Where it exists plentifully in England, it is sometimes burnt, either in admixture with coal itself, or as a cheaper substitute; and it is even stated, that so far is it from being altogether excluded in those counties most noted for coal, that even in Northumberland, as well as Yorkshire, considerable quantities of peat firing are expended.* Its combustion is with some difficulty commenced, but it afterwards burns steadily with the evolution of flame. The disagreeable odour which it gives out is an objection to its use in domestic economy, but this does not apply to its employment in many of the arts. It seems to be admitted, that of all combustibles, peat is that which gives out the most equable and constant degree of heat.

We are informed by Beckman, in his History of Inventions, that in some parts of Bohemia, Silesia, Upper Saxony and other places, it is common to subject the turf used in working metals, to a certain degree of combustion in kilns or furnaces. After undergoing this process, it is supposed to kindle sooner, burn with less air, and to form a more moderate and still more uniform fire than when the article has not been thus prepared. Charred peat is also used by the smiths in some parts of Great Britain, in tempering edge tools. The process of carbonization removes many of the objections to the employment of peat.

GRAPHITE OR PLUMBAGO.

This substance, which is also often known by the name of *Black Lead*, may be ranked among the useful minerals.

Description. Graphite has a dark steel-grey colour, a metallic lustre, and a splendent and metallic streak.

Hardness 1; for it is easily scratched by gypsum, but scarcely by talc. It is sectile, has a greasy feel, and writes readily on paper. Thin laminæ are highly flexible. Opaque.

Specific gravity from 2.08 to 2.45 (*Beudant*).

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sure to the air, it stiffens and consolidates: it is then cut and cross-cut with the spade into cubic masses, which, on becoming dry, are found to burn with great freedom, in consequence of the bituminous saturation, to which the matter of them seems to have been subjected." *History and Description of Fossil Fuel, the Collieries, and Coal Trade of Great Britain.* Lond. 1835.

* *History and Description of Fossil Fuel, the Collieries, and Coal Trade of Great Britain.* Lond. 1835.

Texture sometimes foliated and sometimes granular, often also a little slaty. It has been met with crystallized in six-sided prisms; but nothing is known respecting the angles of these crystals.

Chemical nature. Graphite was for a long time regarded as a carburet of iron; but it is now thought that the iron, which is very variable in quantity, and which indeed seldom exceeds ten or eleven per cent., is entirely accidental. The graphite of Barreros in Brazil, leaves scarcely a trace of residuum when it is burned; and the graphite which forms in high furnaces is sometimes entirely free from iron. Native graphite, however, most generally contains a proportion of this metal, together with variable quantities of earthy matters. This mineral may be regarded as carbon, differing only from the diamond, charcoal, &c. in the mode of aggregation of its ultimate particles.

The localities of graphite in this State are very numerous, but the mineral is seldom found in quantities sufficient for any useful purpose. The limestones of the counties of New-York, Westchester, Rockland, Orange, Ulster, Clinton, Essex, Franklin, St. Lawrence and Jefferson, abound with it, sometimes in the form of irregular foliæ, and sometimes in that of regular six-sided plates.

Dutchess County. There are in this county some important localities of graphite. One of these is on the farm of Mr. Peter Dewint, two and a half miles south of Fishkill Landing. Several tons have been obtained here, and sent to market. It occurs in the granite, in a vein several inches wide at the surface, and increasing gradually as it descends, to two or three feet. About forty or fifty feet of this vein are exposed, and there appears to be every indication that there is an abundant supply of the mineral. The specimens which are obtained at this place are both foliated and granular, and are of sufficient purity for nearly all the purposes to which graphite is applied. There is another vein of a similar kind, but less important, at Fishkill Hooks.

Essex County contains several good deposits of this mineral, especially in the vicinity of Ticonderoga. One of these is about two and a half miles from the village at the Upper falls. It is a vein of the purest foliated graphite, several inches in width. The foliæ often have a radiated arrangement, and are of considerable size. The gangue is calcareous spar, which sometimes exhibits large and perfect cleavages. Granular graphite is also found associated with the above.

This mine has not been much worked, but a considerable quantity of pure graphite is annually obtained from it, which is sold for a shilling a pound. It is thought that this is an extensive deposit.

There are other veins of this mineral in the immediate vicinity, from which large and very pure specimens have been obtained. At the Kirby mine, five miles northwest of the village at the Upper falls, there is a vein of graphite of some width. The mineral is here either granular or in small foliæ, associated with white quartz.

From a statement of property cleared at Whitehall, it appears that there was shipped in 1823, 3840 lbs. of black lead; in 1829, 10,000 lbs.; in 1834, 22,000 lbs. It is probable that a large proportion of this amount was the produce of Essex county. The mines, however, have never yet been worked with any degree of vigour, so that their real value or extent cannot be accurately known.

In Warren County, graphite will probably be found in considerable abundance. There is a locality of it on the farm of Mr. Noble, at Johnsburgh. Several hundred weight of good graphite have been obtained from this mine. The mineral occurs in irregular-shaped masses weighing from one to twenty pounds, in a vein of quartz.

The same mineral occurs in independent masses in the rock. A locality of this kind was discovered in Athol, which contained several tons, the whole of which was sent to market.*

To these localities I will only add here, that graphite is said to occur in considerable quantity in Clinton County, near the Saranac river, from four to six miles from Redford; and that it is thought to exist in workable quantities in the town of Rossie and elsewhere in St. Lawrence County.

The principal uses of this mineral are well known. It is employed in the manufacture of pencils, and for diminishing friction; it also constitutes the basis of the *silver lead*, extensively used as a coating for cast and sheet iron. But the amount consumed for all these purposes is comparatively small.

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* Emmons. *New-York Geological Reports*, 1839.

MINERAL SPRINGS.

The term *mineral* is usually applied to those waters which issue from the earth in the form of springs, and differ from ordinary water in containing a larger proportion of saline ingredients, and in giving out certain gaseous bodies in greater or less quantity. Waters of this description are much more numerous in this State than was formerly supposed; and, with few exceptions, we have within our limits examples of all the different varieties which have heretofore been described. Some of these are of acknowledged importance, as the brine or salt springs, which are here of frequent occurrence; others, as the carbonated and sulphuretted springs, are highly esteemed for their medicinal properties, and have become places of great resort, and sources of wealth to their proprietors.

In the account which I am about to give of our mineral springs, I shall not confine myself to the results of my own observations and analyses, but shall freely avail myself of such works and papers as have been published concerning them.

I shall adopt the following as the most convenient classification, viz:

1. *Brine Springs*, or *Salines*. Those which contain large proportions of common salt as their principal ingredient.

2. *Gas* or *Carburetted Hydrogen Springs*. Those which evolve carburetted hydrogen gas, either pure or mixed with other gases.

3. *Nitrogen Springs*. Those which evolve nitrogen gas in considerable quantity.

4. *Carbonated* or *Acidulous Springs*. Those which give out carbonic acid in sufficient quantity to give a sparkling character to the water. Under this head are included also those springs which are usually termed *chalybeate*.

5. *Sulphuretted* or *Sulphureous Springs*. Those which evolve sulphuretted hydrogen gas.

6. *Petrifying Springs*, with a notice of their products.

BRINE SPRINGS, OR SALINES.

Geographical view. Brine or salt springs, the waters of which contain a large proportion of common salt, and are not charged with a sufficient amount of carbonic acid to entitle them to a place in the class of acidulous or carbonated springs, are of frequent occurrence in the western parts of the State. They have not hitherto been found east of Saltspringville, on or near the line between the Counties of Otsego and Fulton, about fourteen miles from Cooperstown. The springs at this locality, like many others to be hereafter noticed, although containing a very small proportion of salt, formerly afforded supplies of this important article

to the inhabitants in their vicinity. In the strongest of these waters, the amount of saline matter does not exceed three or four per cent. This locality, however, is interesting in a geological point of view, as it occurs in the second greywacke of Mr. Eaton, a formation much older than that in which the great brine springs of the State are found.

In nearly the same parallel of latitude with the preceding, in Delaware County, a brine spring was discovered in 1833. It is situated upon Elk brook, about four miles from the village of Delhi. We are informed that a well has been bored four hundred feet in depth, three hundred and fifty feet being through rock; and that during the boring, several veins of brine were struck, from which some salt has been manufactured. Mr. Mather states that carburetted hydrogen is constantly rising in bubbles through the brine; and that the water, when kept for a few days, smells like free iodine — a substance which he thinks it may contain in some quantity.*

In Oneida County, brine springs occur near Vernon Centre, and again about nine or ten miles west in the same county. These, according to Mr. Eaton, are the first brine springs in the red or saliferous rock of Western New-York; and here, as at various other localities, they are accompanied by carburetted hydrogen gas, which, in some cases, is evolved in large quantities.

At Lenox, in Madison County, a brine spring was discovered some years since, of such strength as to induce several persons to believe that it might be advantageously employed in the manufacture of salt; but these anticipations have not been realized, and the locality deserves to be noticed only in the geographical view which I am now presenting.

A short distance west of the preceding, brine springs have been found at intervals for upwards of a hundred miles, in a range a little west of north. Thus at the Triangle in Broome County, salt water occurs, and the salt obtained from it is of great purity. Brine is said also to exist in the County of Cortland. We next come to the celebrated springs of Onondaga County, to be particularly described hereafter. And finally there are, in nearly the same range, several weak brine springs in Oswego County. One of these occurs in a marsh in the town of Hastings, four miles west of Central Square. Two miles west of this is another, while at Central Square is still another. None of these salines, however, are of much importance, as the amount of saline matter which they contain seldom exceeds twelve ounces in the gallon of water. Similar salines exist also in the towns of Constantia, Richland and Hannibal in the same county.

Mr. Vanuxem remarks, that from the eastern part of Oswego county, to the Niagara river, numerous brine springs are found in the red sandstone; and that these, of which there are several in Oswego, yield the same kind of sharp tasted salt, resembling salt petre, and all highly coloured by oxide of iron; characters different from those of the salt of the brine springs which belong to a subsequent deposit, and which show a difference of source, or contamination from being deposited with a different rock.†

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* *New-York Geological Reports*, 1840.

† Ibid. 1839.

The brine springs of Montezuma, in Cayuga County, come next in order. These have been long known, and have been quite extensively worked; and although the manufacture of salt from them has, for some years past, almost entirely ceased, they are still second in importance only to the Onondaga springs. Some borings have recently been made, with encouraging results. These springs, however, will be more particularly described in another part of this report.

Wayne County contains several salines. Those at Galen were at one time in considerable repute. They are situated in the town of Savannah, immediately on the western edge of the Cayuga marshes. Works were erected there at great expense, but these have been long since removed, and the manufacture of salt entirely abandoned. The reason of this will be apparent, when it is stated that the brine contains scarcely nine per cent. of saline matter, as appears from an analysis of it made some years ago by the late Mr. G. Chilton of New-York. The following are the details of this examination of the Galen brine: Specific gravity 1.0544. 10,132 grains, equal to 38 cubic inches nearly, yielded by evaporation 884 grains of dry solid matter. The results of the analysis, in 1000 grs. of the brine, are as follows:*

Chloride of calcium,	0.49
Chloride of magnesium,	0.29
Sulphate of lime,	2.07
Carbonate of lime,	0.09
Silica,	0.04
Chloride of sodium (common salt),	84.24
Water,	912.78

There is also a spring about two miles from Lockville, at which salt was formerly made in small quantities. And recently it has been reported that a salt spring has been opened in the town of Galen, about fifty rods from the Erie canal, by a boring of two hundred and thirty feet in depth, from which strong brine is forced with great violence by an evolution of gas, probably carburetted hydrogen. The brine is said to be sufficiently pure to furnish good salt without the use of lime.

There is also a brine spring near the head of Little Sodus bay, in this county, on the farm of Mr. Switzer. Of this water, Mr. Conrad informs us that one hundred and forty gallons are required for a bushel of salt;† a strength far below that at which a brine can be profitably employed in the manufacture of salt.

Again, in the immediate vicinity of the village of Clyde, on the canal, salt water, with inflammable gas, has been found by boring. The boring was made by a company in 1832, to the depth of four hundred feet. The brine yielded at first twenty ounces of saline matter to the gallon; but it soon ceased to flow, or was much diluted with fresh water. Gas still occasionally issues from the tube.

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* *Silliman's Journal*, VII. 349. — I have reduced the results of this analysis to the proportions in 1000 grains of brine, which was the amount used in all my own analyses.

† *New-York Geological Reports*, 1837.

A few salines are known to exist in Monroe County, but they are not of any importance in an economical point of view. One of these, found many years since, is on the Irondequoit bay, two or three miles from Lake Ontario. Salt was at one time manufactured from this brine. Another spring, also formerly somewhat worked, is in the town of Greece, two miles north of the Ridge road, and nine miles west of the city of Rochester. To these may be added three springs on the banks of Salmon creek in Clarkson, two miles north of Ladd's Corners. Salt springs are moreover of frequent occurrence along almost all the creeks or small streams, and salt was formerly manufactured from some of them in small quantities.

In 1834, salt water was found in Livingston County, two and a half miles southwest of York, as I was informed by Mr. E. N. Horsford. Strong brine flowed for a few days from the mouth of the well, which was fifty feet in depth; but it subsequently diminished in quantity, and at length entirely ceased to rise.

Salt water has been found by boring in the town of Elba, in Genesee County, eight miles northwest of Batavia; and this has been pronounced by Mr. Hall as the most copious and strongly impregnated saline in the Fourth Geological District. It rises from the true saliferous formation, the rock being the same as that found at Salina.

A number of brine springs have been observed in Orleans County, upon the range of sandstone. In the town of Carlton, three or four miles from Lake Ontario, brine has recently been obtained, one gallon of which affords eleven ounces of dry saline matter. In this case the boring is twenty-six feet through the alluvial, and twenty-seven feet through the red marl and sandstone, in which the brine was first observed. If it shall hereafter be found that the quantity of brine is sufficient, its strength would probably warrant the manufacture of salt to a limited extent, as fuel can be here obtained at a very low price. At Kendall, four miles east of the preceding locality, the manufacture of salt is said to have been prosecuted with profit, though on a small scale, for the last two years.* On examining this brine, I found it to be similar in composition to that from the Onondaga springs, but of inferior strength. At Holley village, three salt springs were known, which have yielded a considerable amount of salt of a very good quality. The works are now, however, abandoned. To these may be added the spring at Oak-orchard, where salt was manufactured by Mr. Bennett, who bored to the depth of one hundred and forty feet, without, however, having obtained an increased quantity of brine.

In Niagara County, according to Mr. Hall, several brine springs occur along the course of Eighteen-mile creek, between Lockport and Lake Ontario. Brine springs, affording small quantities of water, are also found along Golden-hill creek and Johnson's creek. Salt is said to have been formerly made from a spring within three miles of Lockport.†

In Steuben County, there is a salt spring at Lagrange, in the green shale, from which salt was formerly made. It emits bubbles of carburetted hydrogen, but the saline is of no importance.

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* For this and the preceding notice, I am indebted to Dr. James M. Allen. This gentleman also informs me, that during the last summer (1841), brine springs were frequently met with in deepening wells between the Lockport limestone and Lake Ontario.

† Hall. *New-York Geological Reports*, 1838.

Near Rutledge, in the County of Cattaraugus, there are several springs with a slight impregnation of salt. Some attempts have been made to work them, but they have not been attended with the least success.

Although brine springs have not heretofore been noticed in Chautauque County, the frequent occurrence of gas springs would lead us to suppose that brine will yet be found associated with them, as it is in various parts of this State and Ohio.

From this brief account of the localities of the brine springs in this State, it appears that they occur with various degrees of frequency in almost all the counties west of a line passing through Otsego, and bounded on the north by the southern lines of Lewis and Jefferson. It is, however, well known, that favourably as many of these springs are situated, none of them are at present employed to any extent in the manufacture of salt, except those found on the margin of the Onondaga lake. This fact proves most conclusively the superiority of the last mentioned springs, the great importance of which cannot well be over-estimated.

Chemical composition. In regard to the chemical composition of the waters of these different springs, great uniformity is found to prevail. All those which have been subjected to analysis contain, although in somewhat various proportions, the chlorides of calcium and magnesium, and the carbonate and sulphate of lime, in combination with the common salt. All of them, moreover, when freshly drawn, give the characteristic test of iron, which exists in minute proportions in the form of carbonate; or perhaps in some cases the oxide of iron may perform the part of an acid, which, by combining with lime, may thus exist in the form of *ferrate of lime*. Bromine is also known to be one of the constituents of the Salina brine, and it will probably be found in most of the others; but iodine has not yet been detected in any of them. It may be interesting to observe, that all these ingredients are found in sea-water, although the order of combination is somewhat different. In the brine, the proportion of carbonic acid and of iron is usually greater, while that of magnesia is less, than in sea-water; and iodine, which has not been detected in the former, is frequently found in the latter. And to show, that so far as it regards the chemical nature of these substances, there is no inconsistency in the theory that these brine springs result from the solution of beds of rock salt, it may also be stated that all the saline matters which they contain are met with in rock salt, except that the chloride of magnesium is either entirely wanting in the latter, or exists only in very minute proportion. The rock salt of Droitwich and Cheshire contains the chloride of calcium, but not of magnesium. These facts, although they appear to be of little importance, may hereafter be found to have some bearing upon the views which are entertained concerning the origin of our salines.

Brine Springs of Onondaga County. The fact that the State derives an important part of her revenue from these springs, and that they furnish employment and give support to many thousands of her citizens, seems to render it necessary that I should present a detailed description of them; and also that I should offer such suggestions concerning the manufacture of salt, as may be thought worthy of attention.

It is well known that the principal brine springs in this county cluster around the margin of Onondaga lake, a fine sheet of water about six miles in length and one mile in width. The water of this lake is not, as has been stated, salt at the bottom, but is fresh throughout.* The salt water, found every where on the marsh which forms the boundary of the lake, is prevented from communicating with the fresh water, by a bed of marl from three to twelve feet in thickness, below which is a stratum of marly clay.

There are at present on the marsh surrounding this lake, several wells and pump works for the raising and distributing of brine, under the direction of the State authorities, at the villages of Salina, Syracuse and Geddes, and on the Oswego canal near the village of Liverpool.

Salina Wells. There are three or four wells or shafts at the village of Salina, from which brine is obtained. They are from seventy to seventy-five feet in depth; and the brine is raised by means of forcing pumps into reservoirs sufficiently high and capacious to supply the works at this village, and they formerly also frequently supplied the works at Syracuse and Liverpool. According to observations made in July, 1837, the pumps at Salina raised four hundred and eighty-two gallons of brine in a minute, or twenty-eight thousand nine hundred and twenty gallons in an hour. This amount, however, is supposed to have increased greatly since the new shafts have been sunk. The present Superintendent, Mr. Spencer, states that the three new shafts sunk in 1840 afford a large supply of excellent brine of a maximum strength of 75°, which, however, is reduced during the summer to 65°.†

The old Salina well was opened sixteen or seventeen years since. The brine from this I have carefully examined; but its composition probably does not differ, except in the proportion of the ingredients, from that which has recently been brought into use.

The temperature of the Salina brine, during its passage from the pumps into the reservoir, is 50° F., which is probably very near the temperature at its source. The brine is perfectly limpid, and has a somewhat sparkling appearance, owing to the escape of a small quantity of carbonic acid which it contains, and which holds in solution a minute portion of the carbonates of lime and of iron.

Nutgalls and ferro-cyanate of potash, when added to the brine recently drawn, exhibit the changes of colour which are due to the presence of a salt of iron; but they have not the least effect upon the brine after it has been exposed for a few hours to the air. Indeed, even when kept in a well-corked bottle for eighteen hours, these tests produced scarcely any effect. This is owing to the fact that the iron exists in the form of carbonate, and is held in solution by an excess of carbonic acid, and in this state causes the changes of colour which are produced when the proper tests are added; but when this excess of carbonic acid escapes, as it does by the exposure of the brine to the air, the oxide of iron falls down in reddish flocks, and the tests then produce no effect.

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* In the paper on these springs, which I published in 1826, it was stated that the water of Onondaga lake was salt at the bottom, on the authority of Dr. B. De Witt. It now, however, appears, from repeated observations and experiments, that this is not the case.

† *Report of the Superintendent and Inspector of Salt in Onondaga County.* January, 1841.

The specific gravity of this brine is 1.11060 at 60° F. From the information which we possess on this point, it is highly probable that, for a period of at least forty years, its strength has suffered little or no change.* We shall hereafter have a set of observations which will enable us to determine with more accuracy than is at present possible, whether the strength of the brine is subject to periodical variations, and whether it is or is not influenced by the state of the atmosphere.†

1000 grains of the Salina brine, evaporated to perfect dryness by the application of a sufficient degree of heat, left a residuum of 146.50 grains. According to my analysis, the following is the composition:

Carbonate of lime,	0.17
Sulphate of lime,	4.72
Chloride of calcium,	1.04
Chloride of magnesium,	0.51
Chloride of sodium, or common salt,	140.02
Oxide of iron, with a minute portion of silica and carbonate of lime,	0.04
Carbonic acid, holding in solution the carbonate of lime and oxide of iron,	0.09
Water, with a trace of organic matter and bromine,	853.41

This brine contains 1130 grains of pure and perfectly dry chloride of sodium in a wine pint, and 9045 grains or 1.29 pounds avoirdupois in a gallon. It therefore requires forty-three and a half gallons to yield a bushel of salt weighing fifty-six pounds. But as salt made by boiling ordinarily contains not less than five per cent. of water, forty-one and a half gallons will yield a bushel of salt of merchantable quality.

Syracuse Wells. The old well is situated on the marsh, near the coarse salt fields. It is about one hundred and seventy feet in depth, and supplies the salt-works at Syracuse.

According to the observations of Dr. Wright, the late superintendent, and myself, in 1837, the pump at the Syracuse well raises and distributes sixty-two gallons of brine in a minute, although this was thought to be below what it usually accomplishes. The temperature of the brine, as it passes from the tube into the reservoir, is 51° F. It has the same sparkling appearance as the Salina brine; and when recently drawn, behaves with the tests of iron in a similar way, except that the changes of colour are not so rapidly produced.

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* According to Dr. Benjamin De Witt, the specific gravity of the Salina brine in 1801 was from 1.078 to 1.110. (*Transactions of the Society of Arts, &c.* I. 268.)—In 1810, Mr. George Chilton found the specific gravity of the Onondaga brine, probably from the old Salina well, to be 1.0958. (*Silliman's Journal.* VII, 344.)—In 1826, it was, according to my observations, 1.1080; and in June 1837, 1.1088. In September of that year it was 1.11060, as above stated.

† By an act of the Legislature, passed April 18th, 1838, it is required of the Superintendent of the Salt-Works to make weekly observations of the strength of the brine at the several State wells. The instruments in use, which may be called *salometers*, are graduated according to the centigrade scale; that is, distilled water being 0°, and saturated brine 100°. Brine at 75° contains between seventeen and eighteen per cent. of dry saline matter. The observations at the different springs have not yet been continued a sufficient length of time for forming correct conclusions in regard to the variations in the strength of their brines, if indeed such variations do occur. There seems to be no doubt, however, that the strength of these brines is diminished during that part of the season when the pumps are most actively worked.

The specific gravity of brine taken from this well is 1.10499 at 60° F. The amount of dry solid matter in 1000 grains of the same brine, is 139.53 grains. The following are the results of my analysis :

Carbonate of lime,	0.14
Sulphate of lime,	5.69
Chloride of calcium,	0.83
Chloride of magnesium,	0.46
Chloride of sodium, or common salt,	132.39
Oxide of iron, with a minute portion of silica and carbonate of lime,	0.02
Carbonic acid, holding in solution carbonate of lime and oxide of iron,	0.07
Water, with a trace of organic matter and bromine,	860.40

There are 1063 grains of dry chloride of sodium in a wine pint of this brine, and 8506 grains or 1.21 pounds avoirdupois in a gallon; and it requires forty-six and a quarter gallons for a bushel of perfectly dry salt, or about forty-four gallons for a bushel in its ordinary state of dryness.

During the year 1840, two borings were made in the vicinity of the Syracuse pump-house, the one of which (at the time of my visit in December) was two hundred and forty-five feet in depth, and the other two hundred and sixty-five feet. The brine from both these wells was much stronger than is usual in this region. In that from the deepest, the salometer (graduated as heretofore stated) stood at 78° to 79° ; whereas in the other, the instrument stood at about 77° ; showing a difference between these and most of the other brines in this district, of from 10° to 20° on this scale. Both wells furnish daily, brine for the manufacture of 10,000 bushels of salt. On examining the brine from these two wells, previously mixed by Mr. Spencer (the superintendent), and put into bottles which were carefully sealed, I found the specific gravity to be 1.14344. 1000 grains of this brine, when evaporated to complete dryness, left 182 grains of saline matter, or 18.20 in 100 parts.

This saline matter, on further analysis, was found to contain 173.50 parts of common salt; the residue consisted of the usual impurities (as they are called) of the brine, wherever it has hitherto been found in this vicinity, viz. sulphate and carbonate of lime, chlorides of calcium and of magnesium, and oxide of iron, the former being in much the largest proportion. The following will express, with sufficient minuteness for all practical purposes, the composition of this brine, in 1000 parts, viz :

Common salt,	173.50
Various impurities, principally sulphate of lime,	8.50
Water,	818.00

About thirty-five gallons of this brine, therefore, will yield a bushel of perfectly dry salt ; and about thirty-three and a quarter gallons will furnish a bushel of salt in the ordinary state of dryness in which this article is sent to market. The superior strength of this brine will

appear from the fact, that the strongest previously obtained, required upwards of forty gallons for a bushel of salt in the ordinary state of dryness.

Geddes Wells. There are two wells in use at this village. The one nearest the lake is a hundred and twenty-four feet below its level; the other is near the pump-house, and is a hundred and seventy six feet below the level of the lake. During the year 1840, many attempts were made to obtain brine of better quality than that afforded by these wells, but without success.

The temperature of this brine is exactly the same as that of the Syracuse well; it has the same appearance, but the tests of iron produce a more marked effect than upon either of the former. Its specific gravity is 1.10601. The pump at this place raises about a hundred gallons of brine in a minute.

1000 grains of brine from the Geddes spring yielded upon evaporation 138.55 dry solid matter. The composition of the whole is as follows:

Carbonate of lime,	0.10
Sulphate of lime,	4.93
Chloride of calcium,	2.03
Chloride of magnesium,	0.79
Chloride of sodium, or common salt,	130.66
Oxide of iron, with a minute portion of silica and carbonate of lime,	0.04
Carbonic acid, holding in solution the carbonate of lime and oxide of iron,	0.06
Water, with a trace of organic matter and bromine,	861.39

If the above analysis is correct, there are 1051 grains of dry chloride of sodium in a wine pint of this brine, and 8408 grains or 1.20 pounds avoirdupois in a gallon; and it requires about forty-six and a half gallons for a bushel of dry salt, or about forty-four gallons for a bushel of salt in its ordinary state.

Liverpool Well. This well is near the village of Liverpool, twenty-five rods from the Oswego canal, and fifty rods from the bold shore of Onondaga lake. In boring this well, the strata passed through were as follows, viz: From the surface twelve feet, principally marl, similar to that found in the bed of the lake, the shells being mostly broken up and decayed; next to the marl was fourteen feet of fine sand, and below this forty-three feet of a very fine clay of a greyish colour; below this clay, to the depth of eighty-one feet from the beach at low water, was a bed of gravel made up of pebbles of various sizes, with some sand. The brine was first observed in the gravel, although the clay above it had a brackish taste.

The pump which was put into operation at this well in 1837, raises a hundred and two gallons of brine in a minute. This brine, it needs scarcely to be added, closely resembles that from the other wells, but its specific gravity is higher, being 1.11467. 1000 grains yielded 149.54 grs. dry solid matter. The following are the results of my analysis:

Carbonate of lime,	0.13
Sulphate of lime,	4.04
Chloride of calcium,	1.72
Chloride of magnesium,	0.77
Chloride of sodium, or common salt,	142.85
Oxide of iron, with a minute portion of silica and carbonate of lime,	0.03
Carbonic acid, holding in solution carbonate of lime and oxide of iron,	0.07
Water, with a trace of organic matter and bromine,	850.39

There are therefore 1154 grains of pure chloride of sodium in a pint of this brine, and 9236 grains or 1.32 pounds avoirdupois in a gallon. Hence forty-two and a half gallons will yield a bushel of perfectly dry salt, or about forty and a half gallons for a bushel in the ordinary state of dryness.

Brine Springs of Cayuga County. The springs at Montezuma, in this county, were discovered at a very early period by the Indians, and were shown by them to the first white settlers. The brine was originally obtained by digging small holes in the ground a foot or two in depth, in the marsh at the foot of the ridge upon which the village of Montezuma is situated. Subsequently wells were sunk by the whites to the depth of forty or fifty feet, from which brine was obtained in sufficient quantity for the manufacture of salt.

In 1807, salt water was discovered in a branch of the Seneca river, since called Salt creek, at the depth of eight or ten feet from the surface. The brine thus obtained was similar in quality to that in the wells already noticed. In 1810, under the direction of the Cayuga Manufacturing Company, a well was sunk about a hundred feet deep, on the west side of the ridge upon which the village now stands. In sinking this well, three separate springs of water were discovered. The first was about ten feet from the surface, and was like that which had been previously used. Then succeeded a stratum of fine blue clay, five or six feet in depth. Below this was a stratum of hard-pan, with occasionally some gravel, about thirty-five feet in depth. A third stratum of quicksand succeeded, in which was found some weak brine, yielding about ten ounces of saline matter to the gallon. Lastly, there were strata of sand and clay, with some water, to the depth of one hundred feet, where was found the great fountain of brine, which came in through a body of quicksand. This brine, when unmixed with that of the upper veins, is said to have produced twenty ounces of saline matter to the gallon.*

The brine from this well was analyzed by Mr. G. Chilton† of New-York, and found to contain, in 1000 grains,

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* See a Letter from Comfort Tyler, Esq. published in the Appendix to Dr. Van Rensselaer's *Essay on Salt.* Mr. Tyler was one of the first settlers of this county.

† *Silliman's Journal.* VII. 344.

Chloride of calcium,	1.53
Chloride of magnesium,	0.30
Sulphate of lime,	4.31
Carbonate of lime,	0.02
Chloride of sodium,	73.72
Water, &c.	920.12

A year or two afterwards, another well was sunk on the east side of the ridge, and the great fountain of brine was found at the depth of eighty feet. The strata passed through were similar to those in the preceding well. The *New Well*, more recently opened, (I believe in 1824,) was a hundred and twenty feet deep. At a hundred and fifteen feet, the brine was said to have been of sufficient strength to yield eighteen ounces of saline matter to the gallon. On reaching the quicksand, however, the brine rose rapidly, and in two or three days overflowed the top of the well.

In 1823, the salt made at the Montezuma springs amounted to between sixteen and twenty thousand bushels, of which about a thousand were procured by solar evaporation. From that time, the annual produce gradually decreased, until it scarcely amounted to more than a few hundred bushels.

This great depression of the manufacture may be ascribed to several causes. One of these undoubtedly is the rudeness of the pump works. The brine is raised by hand or horse power, and the tubes are so imperfectly constructed that fresh water is continually flowing in and reducing its strength. The soil is, moreover, owned by individuals, and the manufacturer is obliged to purchase or lease it, as well as to erect his works. At the Onondaga springs, on the contrary, grounds are furnished by the State without charge.

Again, the inferior strength of the Montezuma brine has operated unfavourably upon the manufacture at this place. On the other hand, the advantages possessed here, are an abundant supply of wood, and eligible sites for the erection of works on a sidecut from the Erie canal. And it seems to be reasonable and proper that the State should erect pump works at these springs, as she has at those of Onondaga. The importance of this suggestion will be evident from the fact which I have on the authority of an intelligent gentleman of Montezuma, that the cost of raising brine by the rude machinery which they have heretofore been obliged to use, is not less than six cents a bushel. If a good well should be sunk here, and pump works erected under the direction of the State, as at Salina, Syracuse, &c. a new stimulus would be given to the manufacture of salt at these springs. Such an arrangement would add to the revenue of the State, while it could in no way interfere with the manufacture at the Onondaga springs.

The brine obtained from one of the borings made here previously to 1840, had a specific gravity of 1.07543. 1000 parts of the brine yield 101.20 dry solid matter. The composition of the whole is as follows:

Carbonate of lime,	0.18
Sulphate of lime,	5.25
Chloride of calcium,	1.40
Chloride of magnesium,	1.00
Chloride of sodium, or common salt,	93.35
Oxide of iron, with a minute portion of silica and carbonate of lime,	0.02
Carbonic acid, holding in solution the carbonate of lime and oxide of iron,	0.08
Water, with a trace of organic matter,	898.72

This brine, therefore, contains 700 grains of dry chloride of sodium in a wine pint; 5600 grains or 0.80 pound in a gallon; and it requires nearly seventy gallons for a bushel of salt. The strength of the Geddes brine, when compared to this, is about as ten to seven; of the Liverpool brine, as ten to six and a half.

By an act of the Legislature, passed in 1840, an appropriation was made for the purpose of procuring, if possible, a supply of brine of sufficient strength to be advantageously used in the manufacture of salt. A shaft was sunk to the depth of two hundred feet, which opened into a vein of brine much stronger than any heretofore procured in this vicinity. The specific gravity of this brine is 1.09767; and 1000 parts of it contain 129.33 parts of dry solid matter, or 12.93 in 100 parts of brine. This is within one per cent. of the quantity contained in some of the brines which have been worked in Onondaga county; a fact which would seem to warrant further expenditures, and to strengthen the expectations which have been entertained in regard to the establishment of the manufacture of salt at Montezuma.

TABLE

Showing the composition of various brines from Onondaga & Cayuga Counties, in 1000 *parts.*

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Carbonic acid,	0.06	0.07	0.09	0.07		0.08		
Oxide of iron and silica, with a trace of carbonate of lime,	0.04	0.02	0.04	0.03		0.02		
Carbonate of lime,	0.10	0.14	0.17	0.13	8.50	0.18	0.02	
Sulphate of lime,	4.93	5.69	4.72	4.04		5.25	4.31	
Chloride of magnesium,	0.79	0.46	0.51	0.77		1.00	0.30	
Chloride of calcium,	2.03	0.83	1.04	1.72		1.40	1.53	
Chloride of sodium, or pure salt,	130.66	132.39	140.02	142.85	173.50	93.35	73.72	
Water, with a trace of organic matter, etc.	861.39	860.40	853.41	850.39	818.00	898.72	920.12	870.67
Total amount of solid matter in 1000 grains of brine,	138.55	139.53	146.50	149.54	182.00	101.20	79.88	129.33

No. I. From the well at Geddes. Page 107.
II. From the well at Syracuse. Page 106.
III. From the old well at Salina. Page 105.
IV. From the well at Liverpool. Page 107.
No. V. From the new well at Syracuse. Page 106.
VI. From a well at Montezuma. Page 109.
VII. From the old deep well at Montezuma. Page 108.
VIII. From a new well (opened 1840) at Montezuma. P. 110.

Manufacture of Salt.

Under this head, my object is to present a few facts intended to exhibit the advantages which the Onondaga springs possess, and to offer some suggestions concerning the modes of manufacture pursued at the works in their vicinity.

The existence of brine springs on the banks of the Onondaga lake, was made known by the Indians to the late Comfort Tyler, Esq. in the year 1788. The manufacture of salt was soon after commenced, but it was for some years conducted on a very limited scale, and in the rudest manner. Since the completion of the Erie canal, the salt-works have been greatly improved, and the amount of salt annually manufactured has, with few exceptions, been steadily increasing from year to year, as is shown by the annexed statement:

Table *showing the amount of Salt inspected annually at the Onondaga Salt-Works, from* 1826 *to* 1841.

YEARS.	BUSHELS.	YEARS.	BUSHELS.
1826, ...	827,508	1834, ...	1,943,252
1827, ...	983,410	1835, ...	2,209,867
1828, ...	1,160,888	1836, ...	1,912,858
1829, ...	1,291,280	1837, ...	2,161,287
1830, ...	1,435,446	1838, ...	2,575,033
1831, ...	1,514,037	1839, ...	2,864,718
1832, ...	1,652,985	1840, ...	2,622,305
1833, ...	1,838,646	1841, ...	3,134,317

If our estimate of the amount of brine raised by the pumps in operation at Syracuse, Salina, Liverpool and Geddes, be correct, we have a total of 44,760 gallons in an hour, or 1,074,240 gallons in twenty-four hours. If the same amount was raised for three hundred days, it would give a total of 322,272,000 gallons of brine; which, allowing fifty gallons of brine to a bushel of salt, would yield 6,445,400 bushels. This allowance, I think, is sufficient to cover all unavoidable loss in the manufacture; as it appears from the analyses that have been given, that in all the brines, forty-five gallons actually contain a bushel of common salt in its ordinary state of purity.

The following statement will show that heretofore there has been a great waste of brine. In the year 1836, the three pump works were in operation at Salina, Syracuse and Geddes, about two hundred and fifty days. During this period there were raised not less than .... 230,000,000 of gallons of brine, while the amount of salt made during that year fell short of 2,000,000 bushels. At least 100,000,000 of gallons of brine, therefore, were lost; and although this may seem to be a matter of small moment, it will, when properly considered, be found of some importance. The State, it is true, is more interested in it than the manufac-

turers; for, on account of this waste, the expense of supplying the brine is greatly increased.

The great waste of brine rendered evident by the above statement, was in part owing to the distance to which it was carried. Thus the salt-works at Liverpool were formerly supplied with brine from the Salina wells, conducted through wooden tubes; and those at Syracuse were also, in part at least, supplied from the same source. Since the sinking of the wells at Liverpool, and the numerous new ones at Salina and Syracuse, the difficulty has been in some degree obviated; but there is still a great loss of brine, arising from the faulty construction and management of the reservoirs by which the individual works are furnished with brine; and the additional expense which is now incurred in consequence of this waste, should be taken into the calculation in any suggestions which may be offered to improve this manufacture.

As the success of the manufacture of salt depends upon the strength of the brine, price of fuel, etc., a few facts upon these points may not be uninteresting; especially as it is feared by many persons that the abundant supply of coal found near some of the salt springs in other States will have an unfavorable effect upon our works.

The following table will exhibit the relative strength of the different brines from which salt is manufactured in the United States:

At Nantucket, 350 gallons sea water* give a bushel of salt.			
Boon's Lick, Missouri, ...	450	gallons brine,	give a bushel of salt.
Conemaugh, Pennsylvania, ...	300	ditto	ditto.
Shawneetown, Illinois, ...	280	ditto	ditto.
Jackson, Ohio, ...	213	ditto	ditto.
Lockhart's, Mississippi, ...	180	ditto	ditto.
Shawneetown, Second Saline, ...	123	ditto	ditto.
St. Catharines, Upper Canada, ...	120	ditto	ditto.
Zanesville, Ohio, ...	95	ditto	ditto.
Kenhawa, Virginia, ...	75	ditto	ditto.
Grand River, Arkansas, ...	80	ditto	ditto.
Illinois River, ditto, ...	80	ditto	ditto.
Montezuma, N. Y. (old wells,)	70	ditto	ditto.
Grand Rapids, Michigan, ...	50 to 60	ditto	ditto.
Muskingum, Ohio, ...	50	ditto	ditto.
Montezuma, N. Y. (new well,)	50	ditto	ditto.
Onondaga, N. Y. (old wells,)	40 to 45	ditto	ditto.
Onondaga, N.Y. (new wells at Syracuse,)	30 to 35	ditto	ditto.

* Of the sea water at New-York, about three hundred gallons would give a bushel of salt. The following are the results of an examination of a portion of water taken from the East river, at very high tide:—Specific gravity at 60° F., 1.02038. 1000 grains contained 26.80 grs. of dry saline matter, viz: Carbonate of lime, 1.22; carbonate of magnesia, 0.50; sulphate of lime, 0.80; sulphate of magnesia, 1.72; chloride of magnesium, 2.26; chloride of sodium, 20.30; organic matter, traces.—I could not detect the presence of either iron or iodine in this water.

Professor W. B. Rogers thinks that some of the brine wells on the Holston, in Virginia, contain about twenty per cent. of saline matter; which, if the impurities are not in larger proportions than usual, must be stronger than any yet found in this country.

With the above exception, however, the Onondaga brines are the strongest of all the American varieties. But there are still some considerations which should be taken into the account in estimating the relative value of these brines. Thus the Kenhawa brine is said not to contain any sulphate of lime, and hence the process of obtaining the salt in a pure crystalline form is attended with fewer difficulties than usual. Another great advantage possessed at these salines is, that coal may be obtained at comparatively little cost from the hills adjacent to the salt furnaces; and their importance may be judged of by the fact that about 3,000,000 of bushels of salt are now annually made from them.*

The facts just stated are worthy of the attentive consideration of those who are interested in the Onondaga salines. As it is not probable that coal will be found in their vicinity, and as wood for fuel must gradually increase in price on account of the wanton destruction of our forests, every suggestion for economizing its consumption is deserving of careful examination.

It is evident, that in proportion as the strength of the brine increases, the quantity of fuel required for the manufacture of salt will be proportionably diminished. A brine containing twenty-six per cent. of saline matter, like that of Nortwich in England, would of course require less fuel for its conversion into salt, than one which contains only one half of that quantity. It is on this account that the borings recently executed, as they have opened sources of much stronger brine than were previously known, become of great importance; and the attempts to obtain still more highly charged waters should be constantly renewed.

Many expedients are resorted to for the general purpose of economizing the fuel, some of which deserve the attention of those who have the oversight of this important manufacture. Among these may be mentioned the partial evaporation of the raw brine, by causing it to fall in small streams, through faggots of wood arranged across each other, or through a collection of ropes stretched perpendicularly. By these arrangements the brine is divided, and presenting a larger surface, evaporation is facilitated, and the brine collected in the vessels below is much stronger than that which was pumped up. This contrivance is extensively adopted in Lombardy, Saxony, Bavaria and France.† To show the advantage which may be gained in this way, it may be stated that sea water has its density increased from 1.010 to about 1.140. Such an increase of strength would be sufficient to bring the Salina brine nearly to the point of saturation.

Some steps have already been taken in reference to this subject. In 1839, the Legislature appropriated the sum of $15,000 for the purpose of erecting reservoirs, in which the concentration of the brine and the precipitation of the usual impurities should be effected, under the direction of the agents of the State. Ten reservoirs were erected, of one hundred feet in

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* W. B. Rogers. *Report of the Geological Reconnoisance of Virginia.* 1836.

† For a particular description of apparatus, see DUMAS, *Chimie appliquée aux Arts.* Mr. Mather has made a similar suggestion for the concentration of sea water on our coast. *New-York Geological Reports,* 1837.

length, thirty feet in width, and six feet in depth. Of these, two were located at Liverpool, six at Salina, one at Syracuse, and one at Geddes. The raw brine is pumped into these reservoirs, and there allowed to remain for twenty-four or thirty-six hours, subjected to the action of quicklime, and then distributed to the several works. But the limited capacity of these reservoirs is such, when compared with the whole amount of brine consumed, which is estimated at a million and a half of gallons daily, that they do not secure the advantages which might be expected from them. The exposure is not continued long enough to effect the entire separation of the less soluble impurities of the brine. And it becomes a question of great importance, whether these reservoirs shall be increased by the State to the capacity necessary for fulfilling this intention, or whether some other mode of purifying and concentrating the brine shall be adopted.

In favour of the proposition that the business of purifying the brine be conducted by the State, it may be urged, that in this way the purification might be more advantageously and certainly accomplished. There would be a great saving of brine, which would in that proportion diminish the expense now incurred in raising and distributing it; and also, as heretofore stated, of the fuel consumed in the manufacture. Great waste now arises from the numerous private reservoirs; but according to the plan proposed, these might be dispensed with, and the purified brine drawn directly into the kettles or vats from the tubes used for its distribution. It should not be concealed, however, that the erection of reservoirs of sufficient capacity to effect the complete purification of the brine would require a very large outlay; and perhaps, after all, the construction of graduating houses, already referred to, would be more economical, as well as more effective.

In the absence of some general plan of operations similar to those above noticed, great advantage may be secured, as well to the individuals as to the State, by proper attention to the construction of the reservoirs attached to the *blocks* or furnaces. These reservoirs are of course intended to effect the separation of some of the impurities of the brine, either by the simple exposure of it to the air, or by the addition of foreign substances which shall facilitate the desired separation. They should therefore be as large as possible, and should be provided with covers, which may be used during rainy weather, and thus prevent the large admixture of fresh water which is otherwise unavoidable.

Three modes of manufacturing salt are pursued at the Onondaga springs, viz :

1. By solar evaporation.
2. By evaporation with artificial heat.
3. By rapid boiling in kettles.

1. *By solar evaporation.* — This process is conducted in a series of wooden vats, eighteen and a half feet square, and about a foot in depth. Of these there are two parallel rows, which communicate with each other; the one being on a level about a foot lower than the other. The whole operation is extremely simple. The brine is conducted by wooden pipes into the upper tier of vats, where it remains exposed to the sun until crystals of salt begin to shoot out

on the surface. By this time nearly all the less soluble impurities have subsided, and are to be found at the bottom of the vats in beautiful crystals. The brine, thus reduced to saturation, is drawn off into the lower tier of vats, where the formation of salt goes on. It is subsequently taken out and dried, as before, by the heat of the sun; when it consists of large crystals, hard and dry, and of a beautiful white colour. It may be observed, that the evaporation of the brine depends greatly upon the state of the atmosphere, and that the process is of course retarded when there is much humidity. But to prevent the embarrassment which would ensue from the access of rain, by the dilution of the brine, covers are constructed for the vats, which run upon rollers, and may be easily moved when occasion requires.

This, then, is the simple process of nature; and much may be learned by noticing the different steps of the operation. And if, as there can be no doubt, the purest salt may thus be obtained, the difficulties which attend the other modes of manufacture may all be referred to some departure from the principles which are here unfolded.

2. *Evaporation with artificial heat.*—When this mode is pursued, large iron vats are employed, into which the brine is conducted, and afterwards subjected to a moderate degree of heat; the impurities having been previously in a great measure removed, by exposure in the cistern, or by the addition of lime. The heat is either applied directly to the vats, or by means of tubes through which steam is made to pass. In this way, salt of great purity may be obtained, of the crystallized variety. In Great Britain, a similar process has long been advantageously pursued; and the only reason why it has not been more generally introduced here, seems to be the outlay of capital which is required.

3. *By boiling.*—The mode pursued in the manufacture of salt by boiling, is as follows: From twenty to forty iron kettles, such as are used in the manufacture of potashes, are arranged in two parallel rows, and firmly fixed in brick work over a furnace, constituting what is known as a *block*. These kettles, being of a capacity of about one hundred gallons, are filled with brine, which is made to boil. As soon as ebullition commences, the water becomes very turbid, and the calcareous salts begin to precipitate. These are repeatedly removed by large iron ladles, which are placed for that purpose at the bottom of the kettles, and are called *bittern ladles*. A proportion, however, adheres to the bottom and sides of the kettles, and after a few days forms a solid coating, called *pan scale*. When the process is properly conducted, this is frequently removed, as its accumulation retards the boiling and impairs the purity of the salt. Soon after this calcareous matter is deposited, crystals of salt begin to shoot out and sink to the bottom, and this continues until nearly all the brine is evaporated. The salt is now removed to proper places for the purpose of draining off the brine, and allowing it to become dry. This completes the work of the manufacturer. The salt made in this way consists of fine grains, more or less hard and pure, according to the care which has been taken in conducting the process. This is the mode in which by far the largest proportion of the Onondaga salt is still manufactured.

The principal difficulty in the manufacture of salt by rapid boiling is, that the natural pro-

cesses, which so easily and completely purify the salt, are interfered with. Instead of allowing time for the gradual subsidence of the insoluble impurities, and the separation of the more soluble ones, the heat is so high that the precipitation of the sulphate and carbonate of lime is more rapid; and these not being effectually withdrawn by the pans which are used for this purpose, are partly mixed with the salt. The drainage of the salt also is not usually sufficient to remove the deliquescent compounds which the brine contains, and which so greatly injure the character of this salt.

It is a very common practice at the Onondaga works to add lime to the brine contained in the reservoirs, and the same substance is also sometimes thrown into the kettles during the boiling of the salt. This point, among others, was particularly examined by a committee of the Legislature in 1825; and I have found no reason to change the opinion which I expressed at that time, viz. that the addition of lime, if properly made, expedites the process of manufacture, and does not in the least impair the purity of the salt. I should observe, however, that the advantage gained by the use of lime depends upon its purity, and upon the time allowed for its precipitation, before the *salting* commences. When added to the salt during the boiling, it impairs its purity, and may be a fraudulent operation, unless great care is taken in again removing it by the pans with which the kettles are supplied.

The correctness of these views will be evident, upon a recurrence to the changes which the addition of lime causes in the composition of the brine. The excess of carbonic acid which holds in solution the carbonate of lime and oxide of iron in the raw brine, combines with the added lime, and causes a deposit of the whole insoluble carbonate. Moreover, the lime decomposes the chloride of magnesium, and there result chloride of calcium held in solution, and magnesia precipitated. The chloride of calcium thus formed, as well as the amount originally contained in the brine, may be further decomposed by the employment of sulphate of soda, which produces sulphate of lime, presently thrown down, and leaves the salt in a nearly pure form. And if this salt, the sulphate of soda, could be obtained at as cheap a rate as it is in some parts of the world, it could no doubt be advantageously employed for this purpose.

It seems to me, therefore, that there can be no good objection to the use of lime, if it be confined to the reservoirs, as it causes the more speedy separation of the earthy matters, and renders the subsequent salting more rapid and perfect. But I would repeat, that in order to secure its beneficial effect, the lime should be in as caustic or pure a state as it can be conveniently obtained. Lime which has been air-slacked, or which has been previously used in a similar operation, cannot be advantageously employed; indeed, it answers no better purpose than so much sand or clay. And with regard to the addition of this substance to the brine while boiling, I can only say, that if the resulting earthy matters be carefully removed, its use may be tolerated; but it cannot be concealed, that in such cases there is a strong temptation to hurry the process to completion, and thus to mix up the earthy ingredients with the salt.

In some foreign and American manufactories of salt, blood is added to brine, for the purpose of throwing down its impurities; and in some arts, not unlike that now under consideration, powdered charcoal is employed with the same intention. Other articles might be used, but

their high price would prevent their general introduction. All things taken into the account, if a precipitant is necessary or desirable, pure lime, used in the manner and with the precautions heretofore given, will probably be preferable to all others.

To the question which is so frequently asked, How can the manufacture of the fine salt be improved? I can answer only in general terms, by imitating as closely as possible the processes observed in the coarse salt fields. This should be the standard, for here salt is obtained in the purest form, and yet by operations entirely simple, and easily varied to suit particular cases. In applying these principles to the manufacture of fine salt, it cannot be too strongly urged, that the first purification of the brine, or the separation of the less insoluble impurities which subsequently form the pan scale, should be effected in vessels (whether reservoirs or pans) other than those in which the *salting* is to take place. A want of attention to this point is, in my opinion, one of the principal causes of the complaints which have been made in regard to this salt. Indeed, the condition of the kettles, containing, as they often do, a deposit of these impurities of three or four inches in thickness, on which the salt is deposited, and from which it is removed by simple *ladling* and drainage, forcibly exhibits the objections to which this mode of manufacture is ordinarily exposed.

Another objection to the fine salt, as it is often manufactured at the Onondaga furnaces, is, that it is wet, and forms into solid masses which can with difficulty be removed from the barrels into which it has been packed. Its weight is thus almost fraudulently increased, and its value for various purposes seriously impaired. This arises from the want of care in removing the *bitterns*, a term applied to designate the highly deliquescent chlorides of calcium and magnesium. These substances, in consequence of their great solubility, remain with the salt; and the drainage to which it is subjected after being taken from the kettles, is intended to effect their removal. But oftentimes this drainage is not sufficiently long continued; and the result is, that these deliquescent substances are still in a great proportion mixed with the salt. The separation of these might perhaps be more advantageously and completely effected by putting the salt into a vat having a double bottom, and pouring on it small quantities of cold water. Performing this operation, if necessary, two or three times, the bitterns or easily soluble matters would be carried off, while the pure salt would remain; a very small portion only of which would be dissolved. I am satisfied that a strict attention to the two points above noticed, viz. the separation of the less soluble materials in vessels other than those in which the *salting* is effected, and the complete removal of the *bitterns* by drainage or washing, would entirely remove the objections which have heretofore, with too much truth, been urged against the Onondaga fine salt.

I have only to add to the remarks which have already been offered, that several manufactures, in which common salt is employed, might be advantageously carried on in the vicinity of our brine springs. Among these are the soda ash, or British barilla, which is now so extensively used in the manufacture of glass and soap; the various preparations of soda for medicinal use; and the chloride of lime, of which large quantities are consumed in the process of bleaching. The manufacture of sulphuric acid, or oil of vitriol, might perhaps be as well

prosecuted here as elsewhere; and with it and common salt, several subsidiary arts might be established. When we consider the favourable location of the district in which the Onondaga springs are situated, and the facilities of communication which it possesses with the north and west, we cannot doubt that all these advantages will, at no distant period, be fully improved.

For the purpose of determining the relative purity of various kinds of salt, I have subjected them to analysis, and the results are expressed in the following table, in which I have also introduced the analyses of several foreign specimens by Dr. William Henry.

TABLE

Showing the composition of various specimens of Onondaga and foreign salt, in 1000 *parts.**

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Carbonates of lime and magnesia,	------	1.00	0.20	0.38	------	------	0.40	4.32	5.52	2.80	0.23
Sulphate of lime,	7.00	6.50	6.61	5.78	8.92	9.00	20.09	14.88	17.51	13.16†	8.77
Sulphate of soda,	------	------	------	------	------	------	------	------	------	------	2.01
Chloride of calcium and magnesium,	2.00	trace.	1.46	3.50	1.64	2.50	3.26	6.36			
Chloride of sodium (pure salt)	991.00	992.50	991.73	990.34	989.44	988.50	976.25	974.44	976.97	984.04	988.99

	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.
Insoluble matter,	9.00	12.00	10.00	4.00	1.00	2.00	1.00	10.00	1.00	1.00	1.00
Chloride of calcium,	trace.	trace.	trace.	------	------	------	------	0.06	0.25	0.25	0.25
Chloride of magnesium,	3.00	3.50	2.00	28.00	11.50	11.00	5.00	0.07	0.75	0.75	0.75
Sulphate of lime,	23.50	19.00	19.50	15.00	12.00	15.00	1.00	6.50	11.25	14.50	15.00
Sulphate of magnesia,	4.50	6.00	4.50	17.50	4.50	35.00	5.00				
Chloride of sodium (pure salt)	960.00	959.50	964.25	935.50	971.00	937.00	988.00	983.25	986.75	983.50	982.50

No. I. Salt made by solar evaporation at Syracuse.
II. Salt made by solar evaporation at Geddes, by Mr. Brewster.
III. Table salt prepared by A. Woodruff, Salina.
IV. Salt labelled 'extra good,' made by Buel & Foot, Salina.
V. Salt made by boiling saturated brine at the works of Dr. Green, Salina.
VI. Salt made by slow evaporation, Syracuse, Mr. Byington.
VII. Salt made by boiling, at Salina.
VIII. Salt condemned, at Salina.
IX. Salt ditto ditto.
X. Turks Island salt.
No. XI. Liverpool fine salt.
XII. Bay salt, St. Ubes.
XIII. Ditto, St. Martins.
XIV. Ditto, Oleron.
XV. Salt from sea water, Scotch (common.)
XVI. Ditto, Scotch (sunday.)
XVII. Ditto, Lymington (common.)
XVIII. Ditto, Lymington (cat.)
XIX. Cheshire salt, crushed rock.
XX. Ditto, fishery.
XXI. Ditto, common.
XXII. Ditto, stored.

* The specimens from No. I. to XI. inclusive, were analyzed by myself; the remaining ones were analyzed by the late Dr. Henry of Manchester. (*Repertory of Arts*, Vol. XVII. Second Series.) — All the specimens which I examined, were brought, previously to the analysis, to a state of perfect dryness, by a heat of from 400° to 500° F. The loss in weight was from one half to twelve per cent. In Nos. VIII. and IX., the proportion of water was very large. It was probably the imperfect manner in which the drying process was performed, rather than the amount of saline impurities which they contained, that subjected them to the condemnation of the inspector

† And sulphate of magnesia.

Origin of the Brine Springs.

The origin of the brine springs in our State is a subject of considerable interest, whether considered in a scientific or a practical point of view. It has heretofore been observed, that in consequence of the superior strength of the Onondaga brines, they are almost the only ones from which salt may be said to be manufactured in this State. Great benefits have already accrued from the numerous borings which have recently been executed in the great salt basin. None can doubt that the discovery of a brine containing a still larger proportion of pure salt, would be of vast importance, as it would greatly reduce the expense of the manufacture and the price of the salt. In the absence of a more detailed series of observations than we now possess, we may perhaps arrive at some conclusions in regard to the prospect of attaining such a desirable result in future explorations, by a careful examination of the circumstances connected with the origin of these springs.

Upon the supposition that the whole of the interior of this continent was originally covered with the waters of the primeval sea, it is not difficult to imagine that these waters may have remained in various places after the general subsidence, and that by long continued evaporation they may have been brought to the state of concentration which we find in these brines. The extent to which this evaporation must have been carried in the present instance, will appear from the fact that sea-water rarely contains more than four per cent. of saline matter, whereas the Salina brine yields from fourteen to eighteen per cent. But a serious objection to this theory of the origin of our brine springs is, that they are usually at some distance below the surface of the earth, where it is difficult to see how the process of evaporation could have taken place. Moreover, if the increase in the strength of the brine was due to this cause, it would be fair to infer that this process of concentration was still going on, and that the brine was constantly though gradually becoming stronger; of which there seems to be no proof.*

Professor Eaton has advanced the opinion that the brine is produced by combinations continually in progress between the elementary materials furnished by the subjacent rock, and some of the superincumbent strata.† This view is thought to be supported by the fact observed by him, that crystals of salt were formed upon a fragment of the saliferous rock, when exposed to a moist atmosphere. Another fact turned to the same account, is of sufficient interest to merit particular attention. It is the occurrence, in the saliferous rock, of hopper-form cavities and crystals, resembling those of salt formed during an intermission in the application of heat, and commonly known by the name of *Sunday salt*. There are several localities in which these curious productions can be examined. In some cases the hopper-form cavities only are to be found, but in others there are entire strata of regular crystals. Of the latter, the finest exhibition that I have seen, is on the route of the Auburn and Syracuse railroad, about half a mile from the village of Camillus; where for some distance the marly clay, which undoubt-

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* See the facts stated on page 105, in regard to general uniformity in the strength of the Salina brine for the last forty years. The periodical variations to which it, as well as that from other wells is subject, is owing to the different quantities drawn from them by the pumps.

† *Canal Rocks*, page 108.

edly belongs to the saliferous series, is made up entirely of these crystals, varying in size from one to eight inches. One of these crystals, which I analyzed, has the following composition:

Carbonate of lime,	26.25
Carbonate of magnesia,	19.35
Oxide of iron,	4.65
Silica and alumina, or clay,	49.75

Sometimes, however, the proportion of the carbonates is larger; the crystals having their surfaces covered with an incrustation of pure carbonate of lime, and their bases slightly rhomboidal. After an attentive examination of this interesting locality, I was led to the conclusion that these had originally been crystals of common salt which had been dissolved out, and the moulds thus formed again filled with clay, and subsequently incrusted by the percolation of water charged with the carbonate of lime. That this latter process has been going on extensively, is evident from the enormous quantities of calcareous tufa which are found in the immediate vicinity.

A writer in the Philosophical Magazine and Annals of Philosophy, in 1829,* from a review of the facts stated by Mr. Eaton, thinks the water limestone intimately pervaded with the chloride of sodium, which the moisture of the atmosphere, acting upon an exposed specimen, and the water of the springs acting upon the rock *in situ*, extracts and dissolves. Hence carbonate of lime is found in these brines, while the brines of the Cheshire and Droitwich springs in England, which arise from the direct solution of rock salt, to which no carbonate of lime is immediately contiguous, are either entirely free from it, or contain only a minute proportion.

The same author suggests that the crystals of chloride of sodium, which formerly existed in the strata, were deposited at the era of the formation of the saliferous rock, by the same agency which in other parts of the world produced beds of rock salt; and the salt has simply *been dissolved out* at a subsequent period by the percolation of water through the superincumbent strata, leaving impressed in the rock cavities bearing the forms of the crystals; and such, without doubt, he affirms has been one source of the brine springs of this district.

In confirmation of this view, a fact mentioned in Townson's Hungary is also adduced, viz. that the lowest beds of marl in the great salt mines of Wieliczka are mixed with salt in small patches and cubes. If water were to percolate slowly through this bed, the salt would be dissolved, and cubic and other cavities left in the marl, if of a texture sufficiently compact, which would then present a similar appearance to the beds above described.

But this theory, although so plausible at first sight, does not, it appears to me, satisfactorily account for the formation of the large and solid crystals found at Camillus. The occurrence of mere cavities may perhaps be well enough explained in this manner, but it should be recollected that the entire stratum of several feet in thickness is a mass of crystals. It is worthy of suggestion, that these crystals, although they have the form of those of common salt, may

* Supposed to be E. W. Brayley, junior.

have had this form impressed upon them by a very small admixture of that substance. Thus it is known that when a small portion of solution of sulphate of iron is added to a solution of alum, and the whole allowed to crystallize, the sulphate of iron assumes the octahedral form of the alum, although these octahedral crystals contain scarcely a trace of the latter salt. As igneous action was probably concerned in the consolidation of this rock, it is in perfect accordance with the above fact to suppose that the crystalline form of this clay may have been derived from a small portion of salt which they formerly contained. It is certain that this clay is composed of carbonate of lime, silica, alumina and oxide of iron, but does not contain a trace of common salt.* Its occurrence, therefore, cannot be considered of sufficient importance to warrant the conclusions which have been drawn from it concerning the origin of the brine springs.

Several years since I ventured to assert, as the result of an examination of the Onondaga springs, that the most plausible theory was, that they originated from a solution of beds of fossil salt.† This opinion, although quite generally adopted by those who are most familiar with the history of these springs, was nevertheless opposed by some individuals for whose views on subjects of this nature I entertain the highest respect, and I therefore feared that the grounds upon which it rested were insufficient. But after the most careful review of the subject, I have again been brought to the conclusion, that of all the theories which have been proposed to account for the formation of these springs, there is none so free from objection as that which ascribes it to the solution of beds of fossil salt.

I will now briefly state some of the facts which favor this view, and notice some of the objections which have been urged against it. In the outset, however, it should be observed that most of them are applicable to the immediate vicinity of the Onondaga springs; nor does it follow as a matter of course, that if fossil salt exists in their vicinity, it must necessarily be found near all the brine springs of the western region which have been enumerated. There are many instances of the occurrence of brine springs in England and France, at a considerable distance from any hitherto discovered bed of salt; and it is only when the brine has attained a certain degree of strength, that this mineral is to be looked for in the immediate vicinity.

A boring was made several years since at Vic, in the very centre of the saline district, in the department of La Meurthe, in France. They first passed through strata of freestone and clay, intersected by veins of sulphate of lime. At the depth of about fifty metres,‡ the clay and sulphate of lime which the borer brought up, began to be mixed with rock salt, and continued so till about the sixty-fifth metre, at which the bed of rock salt began.

The account adds, that at the present time (September 1819), the boring has reached to 85 metres; thus passing through more than twenty metres of salt, divided into three beds by the thin strata of sulphate of lime, and the borer continues to bring up salt.

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* There is a clay found in the immediate vicinity of this crystallized stratum, which is often incrusted with crystals of sulphate of magnesia. A specimen which I analyzed, contained in addition to the carbonate of lime, silica, alumina and oxide of iron, about twenty per cent. of carbonate of magnesia.

† *New-York Medical and Physical Journal*, V. 176.

‡ A metre is about 39.37 English inches.

It may not be unimportant to observe, that in the neighborhood of this boring, brine springs had been worked before the christian era; and that the above is the only locality of fossil salt which is known in France.*

In noticing the salt mines of Hallein, in Hungary, Beudant remarks: "We observed in the midst of these clays, beds of salt sufficiently large, grey or reddish, and containing in some places, pellets of argillaceous matter. We find especially fibrous gypsum, some veins of anhydrite, and beds of a brown compact gypsum of a grey lustre and somewhat scaly fracture."†

The account given of the salt springs of Worcestershire, in England, by an accurate observer, Dr. Charles Hastings, applies in almost every important particular to the region around the Onondaga springs. This author remarks, as others have done, that "wherever rock salt is met with, sulphate of lime or gypsum seems to be very generally discovered in mixture with the earthy strata above it. In most parts of the world where these gypseous strata are found, marine shells are mixed with them; but this has not been discovered to be the case either in Cheshire or in this county."

Dr. Hastings gives the following section from the surface in the town of Droitwich: "First, a stratum of mould, three feet deep; then a stratum of red marl forty feet deep, which abounds with water of a brackish nature. After that, a stratum of marl which extends for one hundred and thirty feet. In this marl there are no springs of water; it is quite dry, but is penetrated with perpendicular veins of gypsum. At the distance of a hundred and thirty feet from the commencement of the gypsum in the marl, we come to the strong brine, which rushes up to the surface as soon as it is bored into. This brine is ten feet deep, and the rock salt is under this river of brine."‡

I have introduced these notices of particular localities of rock salt, rather than the general ones contained in geological treatises, because the facts can be the more easily applied to the case under examination. And it may be observed that the most prominent of these is the constant associations of gypsum with the rock salt formation.§ In this particular, the similarity of the formation around the Onondaga lake appears to me to be fully established. About a mile from Syracuse, on the railroad from that village to Split Rock quarry, is a conglomerate made up of pebbles of various sizes and colours, and firmly aggregated by an argillaceous cement. This stratum is three or four feet in thickness, and continues for some distance. In the marsh about a mile and a half from Syracuse, is an extensive deposit of marl, similar to that found in the immediate vicinity of Onondaga lake; and large masses of calcareous tufa are also found in this valley.

Beyond this bed of marl are extensive beds of gypsum, of the several varieties which are known to occur in Western New-York, viz. the lamellar, the fibrous, the dark coloured and the earthy. The specimens of the fibrous variety are more beautiful than any which I have here-

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* *Annales de Chimie et de Physique*, XII. 48; or *Repertory of Arts*, Second Series, XXXVI. 186.

† *Voyage Minéralogique et Géologique en Hongrie pendant l'année* 1818. Par F. S. Beudant. I. 169.

‡ *A Lecture on the Salt Springs of Worcestershire, (England.) with an Appendix*, by Charles Hastings, M. D., F. G. S.

§ This is by no means confined to the *anhydrite*, as has been asserted, but includes also the hydrous gypsum exactly similar to that found every where in the western part of this State.

tofore seen from this State, the fibres being often more than two inches in length. But by far the largest proportion of the gypsum at this locality is in thin layers of the fibrous or foliated kind, alternating with the dark coloured earthy variety, which is indeed nothing more than a gypseous clay. It may also be stated that both the rock and the clay associated with this mineral effervesce strongly with acids, and contain a large proportion of carbonate of lime.

In digging a salt well at Liverpool, three miles north of Syracuse, fibrous gypsum was found twelve feet below the surface, in strata of black mud intermixed with slate; both above and below the strata, was found soft red rock, or indurated clay, full of seams, through which the salt water passes.*

Simeon Ford, Esq. for several years engineer of the pump works at Salina, in describing the well which had been sunk in the marsh by the Syracuse and Onondaga Salt Company, says, "The strata of earth, to the depth of thirty-four feet, consisted of hardpan and chocolate-coloured clay, intermixed with thin layers of sand. In the clay were found imbedded stones of different sizes, from half a pound to half a hundred in weight, consisting of granite, quartz, red and white sandstone, grey and blue limestone, sulphate of lime and slate, together with pieces of fine potter's clay."†

In another part of this communication, Mr. Ford states, that "salt water is found flowing in small veins on the marsh, the whole distance round the south end of the lake, from Liverpool to the mouth of Nine-mile creek, a distance of nine miles. In any part of the marsh for that distance, by digging down two feet, salt water will be found, though of very inferior quality, and will rise above the ordinary level of the lake at low water. The marsh is composed of a stratum of common shell marl; passing through the marl, the next stratum is hardpan, and next chocolate-coloured clay. In the hardpan and clay, small veins of salt are found; some rising perpendicularly, and others running in horizontal lines. A horizontal vein of salt water enters the well now used, about two feet from the bottom, five inches in diameter. Through this, a stream is constantly pouring into the well; the coating of the vein appears to be sulphate of lime, and forms a perfect tube for conducting the salt water."‡

The description here given agrees generally with the section of the boring of the Geddes well, a hundred and seventy feet below the level of the Onondaga lake. A copy of this section was furnished to me by Mr. J. J. Rice, who conducted the work, under the direction of Mr. Earll, in 1831. The red and blue marly clay alternated at various depths, and the brine increased in strength from 11° to 48°, by an instrument on which the point of saturation was at 60°.

I might add to the above, the description of the strata passed through in boring for brine at Montezuma in Cayuga county,§ where these various coloured clays, conglomerates and gypseous veins, were also observed; but their close resemblance to the strata near Salina and Syracuse renders it unnecessary. And it may be as well to state here, that all the clays around Salina and Syracuse contain large proportions of carbonate of lime. In one specimen from the vicinity of Syracuse, I found

* *American Journal of Science*, XVI. 377. † *Legislative Documents*, February 3, 1826. ‡ Ibid.

§ The details on this subject are given by Mr. T. Conrad. *New-York Geological Reports*, 1837.

Carbonates of lime and magnesia,*	89.00
Silica and alumina coloured by oxide of iron,	11.00

With minute proportions of the chlorides of sodium and calcium.

They therefore all belong to the class of marly clays, which are so constantly associated with fossil salt.

Having noticed the striking similarity in the formations near the Onondaga springs to those of many localities of fossil salt, I must also advert to a fact which by many persons is thought greatly to favour the theory now under consideration. It is, that the strength of the brine is influenced by the height of water in the Onondaga lake. Thus it is asserted, that in the early part of the summer, when the water in the lake is high, the brine contains a much larger amount of saline matter than at any other time. Dr. Wright, the late superintendent of the salt-works, informed me, that during the spring of 1836, when the water in the lake attained an unusual height, the brine at the Salina well had a density of 79° by an instrument on which the point of saturation was 100°; whereas ordinarily it does not exceed 63° or 64°. This extraordinary density continued only a short time; but a density of 70° is said to be no unusual occurrence under such circumstances. The increased strength of the brine in the early part of the season is supposed to be accounted for by the fact, that as the quantity of water discharged from the pumps during the winter is comparatively small, the brine continues for a longer time in contact with the fossil salt, and becomes more strongly impregnated with it; and again, when the quantity of water in the lake is large, the increased pressure upon the river of brine below, causes the stronger solution to rise higher in the well than at other times.

We have here a singular illustration of the manner in which the same general fact is employed to strengthen theories directly opposite. Dr. S. P. Hildreth, in a paper on the bituminous coal deposits in the valley of the Ohio, etc., thinks the opinion that the brine springs in the valley of the Ohio are not supplied from a deposit of rock salt, but from salt in small grains or particles pretty equally diffused, strongly confirmed by the fact that the brine becomes weaker in a well worked very constantly, and the necessity of boring deeper to renew the strength of the water. For, says he, "if the water was supplied from a deposit of pure solid salt, the well would remain of uniform strength. Another proof is founded in the fact, that the *deeper* wells are supplied with a stronger water; showing that the further the saline strata are penetrated, the more certain they are to yield a strong brine."*

The fact just stated, viz. that the strength of the brine increases with the depth of the well, applies also to the Onondaga springs; and I should have offered it, among others, in favour of the theory that they have their origin in fossil salt; for, if I am not mistaken, at every locality of this mineral, the brine increases in strength from the surface, until it is in immediate contact with the bed from which it derives its saline impregnation. Nor does there seem to me to be any thing in the fact that the strength of these brines diminishes on being worked, which is at all inconsistent with this view.

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* *American Journal of Science*, XXIX. 1.

In connexion with the inquiry into the origin of these brine springs, it deserves to be stated, that funnel-form cavities of various dimensions are observed every where on the high grounds which constitute the boundary of the Onondaga lake. Some of these have been formed at a very remote period, as is evident from the size of the trees found in them. Others are of more recent origin, and present the appearance of deep and perfectly regular wells or excavations. Dr. Benjamin De Witt, in a memoir on the Onondaga salt springs, states, "that at a distance of half a mile from the Salt Point (Salina), there is a pit lately sunk into the earth; it is four or five feet wide, descends twenty feet perpendicularly, and then appears to take an oblique direction downwards." "This," he adds, "is supposed by some to have been caused by a vacuity underneath, produced by the solution of a body of salt in the waters which lead to the springs."*

I was so fortunate as to have the opportunity of examining a cavity of a similar kind, formed during the latter part of the month of May, 1837. It was on the grounds of Major Burnet, a short distance from the court-house, about half way between the villages of Salina and Syracuse. The cavity, at the time when I visited it, was fifteen or sixteen feet deep, and about ten or twelve feet in diameter, and had a roundish or oval outline. The sides of this pit or well were perfectly smooth, and it had the appearance of a work of art. At the depth of ten or twelve feet, there was a stratum of reddish indurated clay, which had been broken off and carried in an oblique direction downwards; thus agreeing very well with the description given of a similar cavity by Dr. De Witt. Upon subjecting to analysis a portion of this clay, I found it to be composed, as already stated, of carbonates of lime and magnesia, alumina, silica and oxide of iron, together with minute portions of common salt and chloride of calcium.

The formation of these cavities or *sink holes* may be explained upon the supposition that beds of some soluble mineral exist at considerable depths below the surface; and that by the washing away of blocks or masses of it, a vacuity is produced, and the strata of earth, clay and rock, thereupon subside. But as these are by no means uncommon in limestone and gypseous regions, I was not prepared to attach much importance to their occurrence in the vicinity of the brine springs, until I found that they had also been observed near the beds of rock salt in Cheshire† and Worcestershire in England.

Dr. Hastings, in the account of the salt springs of Worcestershire, already quoted, states the following fact with regard to the discovery of rock salt at Stoke Prior. Without the least apparent indication of the existence of this mineral, it seems that one of those persons called *brine smellers*, pronounced that there was salt in that vicinity.

"As to the rule," says our author, "by which the said Cheshire brine smeller determined that there was salt at Stoke Prior, I know nothing; but he attached great importance to what he called brine slips. By brine slips it appears that he meant a sudden slipping of the red marl which sometimes occurs about Droitwich. It not very uncommonly happens in this district, that on a sudden, a chasm will be formed twenty or thirty feet long, and a foot wide,

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* *Transactions of the Society of Arts, etc., of the State of New-York.* I. 268. (1801.)

† Holland. *Survey of Cheshire,* page 20.

by the giving way of the ground. These chasms are of great depth, and it is supposed by many persons that they communicate with salt strata below. Whether this be true or not, it is certain that the Cheshire salter assured his Worcestershire friends that he smelt the salt at these chasms, and hence inferred that the work of mining might be attempted with security. He probably drew his inference, not from the sense of smell, but from the appearance of the marl. The result has at any rate proved him right in his prognostication, for solid rock salt was here for the first time found in Worcestershire."*

It may also be here stated that the views which I have been led to adopt concerning the origin of these brine springs are, in part at least, supported by the observations of Professor W. B. Rogers, concerning the salt springs of Virginia. "At the salt works on the Holston," says he, "the wells are usually from 200 to 300 feet in depth, presenting strata of limestone near the surface; sandstone or slate alternating with beds of gypsum several feet in thickness, next beneath; and finally a stratum of clay, within which the salt water is procured. This clay is of a reddish aspect, and a very argillaceous texture, being in all probability a softened shale, such as that of the brine springs and rock salt of Cheshire in England. In fact, a marked analogy is presented in the structure of the salt region of the Holston and that of Cheshire. In the latter, beds of gypsum are found alternating with strata of indurated clays and sands, approaching to slates and sandstones; and carbonate of lime exists largely in the strata lying near the surface. In all these particulars the salt region of the Holston corresponds with it very closely.

"The great value of the Cheshire region, however, results from the heavy beds of rock salt which it includes; and of the existence of such upon the Holston, though far from improbable, no positive testimony has as yet been obtained.

"The curious fact, that on some occasions granules or small crystals of salt are brought up by the water of the wells, is certainly very much in favour of the opinion that such beds of massive salt do actually exist at depths to which the borings hitherto made have not been extended, and furnishes strong additional incentives to a persevering and thorough exploration, by boring in numerous places, penetrating to still greater depths."†

Quite recently we have been informed that fossil salt has been discovered eighteen miles from Abington, in the county of Washington, in Virginia. At a boring which was there executed, strata of gypsum were met with at the depth of thirty feet from the surface. Fossil salt was found at the depth of two hundred and thirty feet, and it continued for fifty or sixty feet. The salt is highly crystalline, but of a reddish colour, probably owing to an admixture of iron.‡ Those who are interested in this subject will look anxiously for a more minute description of this locality, which may be expected in the forthcoming report of Prof. Rogers.

During the year 1838, in pursuance of an act of the Legislature, a deep boring was exe-

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* The occurrence in the vicinity of Salina and Syracuse, of weak brine springs impregnated with sulphuretted hydrogen, is another point of resemblance between this region and that in Worcestershire, (England,) where fossil salt occurs, which is particularly worthy of notice. A description of these springs will be found in a subsequent part of this report.

† *Report of a Reconnoissance of the State of Virginia*, by W. B. Rogers. 1836.

‡ *American Journal of Science.* XLI. 214.

cuted at Salina, with the hope of obtaining rock salt or a stronger brine than had hitherto been found in this district. I need hardly say that in both these respects the attempt was an unsuccessful one. The boring was continued to the depth of six hundred feet, passed through the alluvial, strata of shales of various colours, a thin sandstone bed, and finally penetrated into the black limestone of the protean group of Mr. Vanuxem.*

It might be supposed that the failure to discover a stronger brine or rock salt by this deep boring, is conclusive evidence against the theory of the formation of these salines by the solution of this mineral; but this would be an incorrect conclusion. The selection of the place for the boring was perhaps injudicious. The fossil salt, which is the source of these waters, may be at some distance from the springs themselves. Besides, we now know that a much stronger brine has been obtained since that deep boring was completed; and by continuing these excavations, still more highly charged brines may hereafter be discovered. When we reflect how many years of effort were required to unfold the treasures which were concealed near many of the English brine springs, we should not despair of similar results here merely in consequence of the failure of a few comparatively trifling attempts.

An opinion was advanced many years since, and has been recently revived, that these salines are of volcanic origin, being an application of the general theory of Hutton to the formation of rock salt. Dr. Dewitt, in the memoir on the Onondaga springs, to which I have already referred, remarks, that in applying this theory, "we may naturally suppose that the large cavity in the earth now occupied by Onondaga lake has at some early period been the mouth of a tremendous volcanic eruption, producing by its intense heat a sudden evaporation of sea water, which it happened to meet in the interior of the earth. This idea, if admitted, will at once account for the formation of a lake, and the production of a salt mine; at the same time, it leads the mind to conceive, with more facility, of the probable magnitude of the latter. Great indeed must be that body of salt which we may suppose to be produced by a torrent of heat nearly six miles in diameter, volatilizing and dissipating the waters, and leaving the fixed and solid materials in accumulated heaps."†

These are interesting views; but it will be evident that they do not in the least affect the question now under consideration. The rock salt, whether it is an original deposit, or whether it is the result of volcanic action or any other agency, may now be in the act of solution by those waters which form the brine springs. This view appears to me to afford the most satisfactory explanation of the origin of these springs, and to be most consistent with all the facts which are known concerning them.

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* For particulars in regard to this boring, by Mr. Vanuxem and Dr. Allen, see *New-York Geological Reports*, 1839.

† *Transactions of the Society of Arts, etc., of the State of New-York*, I. This view has also been adopted by Rafinesque, *Atlantic Journal*, I. 73; and Vanuxem, *New-York Geological Reports*, 1839.

GAS OR CARBURETTED HYDROGEN SPRINGS.

One of the most interesting facts connected with the history of mineral springs is, that some of them constantly give out an inflammable gas, which on examination proves to be carburetted hydrogen, often in a state of great purity, but occasionally mixed with small portions of other gaseous bodies. This gas is also sometimes observed to issue from clefts in rocks, and from water of ordinary purity; and the close resemblance of its flame to that of coal gas, seems at first sight to warrant the conclusion that it has its origin in the decomposition of coal; but this, however, is far from being in every case the true theory of its formation.

Carburetted hydrogen may be distinguished from sulphuretted hydrogen, the gas which characterizes what are called sulphureous or sulphuretted springs, by its not possessing that offensive odour, and by its not producing those changes in metallic solutions, which are such marked properties of the latter gas.

Carburetted hydrogen may sometimes be obtained, mixed, however, with small portions of carbonic acid and nitrogen gases, by agitating the bottom of a stagnant pool, especially if it is formed of clay. Its production under such circumstances is usually ascribed to the decomposition of vegetable matter; but this explanation is in some cases quite unsatisfactory.

A locality of this kind just noticed occurs in the town of Northeast, in the County of Dutchess; where, from the bottom of a small lake, proceeds inflammable gas of considerable purity. A short distance from Ameniaville, in this county, the same gas rises from the bed of a small stream.

In New-Lebanon, in the County of Columbia, one or two similar springs have been observed.

Albany County. Inflammable gas is quite abundantly evolved through a boring made into the slate in the southern part of the city of Albany. Here it appears to be associated with the carbonated water, to be hereafter noticed. Sulphuretted hydrogen also issues from the same boring, but its source is much nearer the surface than that of either of the other gases. That these gases are not connected with each other, and proceed from different layers of the rock, is proved by the fact, that upon sinking down a tube, the mineral water is obtained uncontaminated with either of these substances.

The gas which issues from the Albany spring burns with a white flame tinged with red; and at length, when the flow of gas is temporarily impeded, the flame is of a blue colour, owing probably to the imperfect combustion. When a current of the gas is made to pass through a solution of acetate of lead, no change of colour ensues; hence it cannot be mixed with sulphurctted hydrogen.

Oneida County. Carburetted hydrogen gas issues through a crag or gravelly soil about a mile west of the village of Vernon, in this county. According to Prof. Eaton, who made several trials in July, 1823, it issues through a spring of water at the rate of a gallon in a minute. He states that he observed it "issuing from several small masses of water along the foot of the same hill; which naturally induced a belief that it rises from the earth in all parts

of several acres of ground adjoining the chief spring. The underlying rocks are fields or patches of ferriferous rock, resting on the saliferous rock. The gas burns with a flame of a reddish white colour, and blue at the base."*

Ontario County. Carburetted hydrogen is evolved in considerable abundance in various parts of this county. The most noted locality is in the town of Bristol, about nine miles west-southwest from Canandaigua, where it issues in a ravine on the west side of the valley of Mud creek.

Dr. Hayes, from the experiments which he made upon this gas, arrived at the conclusion that it consists principally of the light and heavy carburetted hydrogen; and that it contains carbonic acid, but no sulphuretted hydrogen. Mixed with a small proportion of olefiant gas obtained from alcohol, and inflamed in a proper burner, it forms a brilliant gas light.†

At Cheshire, five miles east of the preceding, there are several places from which jets of this gas issue from clefts in the rock. It is observed, however, in much the largest quantities, according to Mr. Hall, in Manchester on the east side of Canandaigua lake, its occurrence being manifested for a considerable distance along the same range. The earth around the openings where the gas issues is of a dark colour, owing to the copperas which is formed by the decomposition of iron pyrites.‡

In Yates County, a mile or a mile and a half from Rushville, in the town of Middlesex, Dr. Hayes, in the paper already quoted, states, that on the southeastern side of a valley called Federal Hollow, there are numerous jets of this gas. "In a field near the northeastern extremity of this tract, and at an elevation of forty or fifty feet from the bottom of the valley, several hillocks may be seen of a few inches in height, and from two or three to ten or twelve feet in diameter. They consist of black mould, and are destitute of vegetation; from these gas issues, and on digging into the earth beneath, may be obtained in considerable streams. These hillocks have appeared successively, within a period of seven or eight years, although the ground has been cleared much longer. The first indication of their formation is the disappearance of vegetation at a particular point; this is enlarged, the mould accumulates and the hillock is gradually formed. In very cold weather, the gas is said to issue from the tops of hollow cylinders of ice, sometimes two or three feet in height, forming when lighted in a still evening, a beautiful illumination."

In Monroe County, in the town of Riga, inflammable gas rises from a spring, in sufficient quantities to supply a constant flame from a half inch tube.

Niagara County. In the town of Royalton, six and a half miles east of Lockport, carburetted hydrogen issues through the water of a basin on the south side of the Erie canal. This is said by Prof. Eaton not to have been observed until the water was let into the canal. Upon testing this gas, it was found to resemble that at Vernon, but it approached nearer to the character of light carburetted hydrogen. A large proportion of the flame is blue. The quantity

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* *American Journal of Science*, XV. 236.

† Account of the Inflammable Springs of Ontario County, by Dr. P. Hayes. *New-York Medical and Physical Journal*. III. 49.

‡ *New-York Geological Reports*, 1839.

which issued through the basin at one place exceeded a gallon a minute. This place was named *Gasport.**

Chautauque County. By far the most interesting exhibitions of the evolution of carburetted hydrogen which occur in this State, are to be observed in this county. The village of Fredonia, indeed, has attracted much attention in consequence of the gas springs found in its immediate vicinity, although they are by no means confined to this particular locality.

The village of Fredonia is situated on the Canadawa creek, about three miles south of Lake Erie; and the gas springs seem to have their origin in the strata of slate which form the bed of the stream, and which are every where met with in this vicinity, a short distance from the surface of the earth. This slate has a bluish colour, and some of the layers are exceedingly fragile, requiring only a few years exposure to be completely converted into a clayey soil. The lower strata, however, resist atmospheric agencies, and are sometimes used as a building material. When recently broken, this slate always emits a strong bituminous odour, and it frequently contains thin seams of a substance resembling bituminous coal. Most commonly, however, this bituminous matter occurs in patches, having more the appearance of detached vegetable impressions, than of a regular stratum.

Through fissures in this rock in the creek near the village, are every where to be seen bubbles of gas rising through the water. The evolution, however, is most abundant at the bridge, and about three quarters of a mile below. The gas, when collected in a proper vessel and fired, burns with a white flame tinged with yellow above, and blue near the orifice of the burner. Its illuminating power is not inferior to that of ordinary coal gas. When mixed with atmospheric air and ignited, it explodes violently. It contains no admixture of sulphuretted hydrogen.

The illuminating power of this gas and its abundant supply, suggested the idea of its employment in lighting the village. A copious discharge of the gas was observed issuing from a fissure in the rock which forms the bed of the creek, which it was thought could be diverted to a boring on the bank. A shaft was accordingly sunk through the slate about twenty-two feet in depth, which occasionally passed through layers of the bituminous substance already described, and the result was that the gas left the creek and issued through the shaft. By means of a tube, the gas was now conducted to a gasometer, and from thence to different parts of the village. The gasometer had a capacity of about two hundred and twenty cubic feet, and was usually filled in about fifteen hours, affording a sufficient supply of gas for seventy or eighty lights.

Bubbles of the same gas are here and there seen rising through the water in this creek for nearly three quarters of a mile below the village; but the largest quantity is evolved at the latter point. It was not possible for me with any apparatus which I could command, to determine the amount of gas given out at this place in a given time; but bubbles rise with great rapidity from an area of more than twenty feet square, and I should probably be warranted in asserting that it is five or six times greater than that obtained at the village.

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* *American Journal of Science.* XV. 237.

At Van Buren Harbour, on Lake Erie, four miles from Fredonia, bubbles of inflammable gas may be seen rising through the water when the lake is calm, a rod or two from the shore. The same thing is also observed for three miles northeast of Portland Harbour, and at Buffington's well. The light-house at the former place is illuminated with this gas, which for that purpose is brought from the margin of a small stream about half a mile distant.

In the town of Sheridan, six and a half miles from Fredonia, the same gas is abundantly evolved in various places. And again on the west branch of Canadawa creek, four miles southeast of that village, the carburetted hydrogen rises in considerable quantity through a spring of pure water in a marsh. This gas, when collected and forced through a small orifice, burns with a bluish white flame.

The evolutions of this gas are not confined to the localities enumerated; but are elsewhere of frequent occurrence. Sometimes also the escape of the carburetted hydrogen is accompanied with petroleum, which forms a pellicle on the surface of the water.

In Cattaraugus County, Mr. Hall states that carburetted hydrogen gas escapes from almost all the waters, whether stagnant or otherwise. It is evolved in small quantities at the Oil Spring in Freedom, but it will not sustain a constant flame.

To this account of it may be added, that carburetted hydrogen rises through several brine springs, as at Clyde in Wayne County; in the valley of Elk creek, three and a half miles from the village of Delhi, Delaware County; and at La Grange, in Steuben County.

Origin of the Carburetted Hydrogen.

The evolution of this gas is so abundant, and extends over such a large surface, that we must refer its origin to some general cause. In Chautauque county, as I have already remarked, the strata of slate have thin seams or patches of a bituminous matter, which burns with a flame entirely resembling that of the gas which is so copiously disengaged through its fissures. With this slate, there alternates a sandstone, which every where contains small cavities filled with petroleum; and all the specimens of which give out a strong bituminous odour. This liquid substance appears originally to have been diffused throughout the whole mass of the rock, both sandstone and slate, and to have given to it the peculiar character which it now possesses.

It is probable that the gas so copiously discharged, is formed by the action of heat upon the bituminous matter thus generally diffused through the strata of sandstone and slate; or it may be that the same matter which, in the upper strata is solid or liquid, is, at greater depths, the gas kept in a liquid form by the pressure of the superincumbent strata. A fact which I observed at Fredonia confirms this view, and in my opinion proves that there is, at some distance below the surface, a vast reservoir of gas, the evolution of which is prevented by the pressure exerted upon it. The fact to which I refer is, that when the water in the creek is low, bubbles of gas are often observed, which disappear entirely when the water has risen, as after a rain. And again, gas may be obtained at almost any part of the bank by boring to the depth of twenty or thirty feet. So common, indeed, is this occurrence, that many of the

wells in the village of Fredonia are strongly charged with the gas. It may also be added, that there are frequently to be observed in this vicinity disruptions in the strata of slate, which have probably been caused by some expansive force exerted from beneath.

Mr. Storke, one of the engineers on the Buffalo and Erie railroad, obligingly furnished me with the height of several points in the vicinity of Fredonia, from which some conclusions can be drawn concerning the thickness of the strata which are impregnated with this bituminous matter.

It will be recollected that the gas issues through the strata of slate which form the bed of Lake Erie, as at Van Buren Harbour.

The slate on the bank of the Canadawa creek, at Fredonia, through which the carburetted hydrogen issues, is a hundred and thirty-seven feet above the level of the lake.

The Laona sandstone quarry, the rocks of which contain petroleum, and have a strong bituminous odour, is two hundred and forty-one feet above the level of the lake.

The gas spring, four and a half miles southeast of Fredonia, is four hundred and eighty-one feet above the level of the lake.

On the west branch of the Canadawa creek, six miles south of Fredonia, at the height of six hundred and seventy-four feet above the level of the lake, the same slate occurs.

Three miles northeast of Jamestown, at the height of nine hundred and twenty-six feet above the level of the lake, is a quarry of sandstone.

The strata of sandstone and slate are, therefore, ascertained to be nearly a thousand feet in thickness.

Extending the computation to the other strata through which this gas is evolved, we find it at Albany upwards of four hundred feet below the surface, or about three hundred and seventy feet below tide, issuing through slate.

At Vernon, in Oneida county, through the red sandstone, nearly four hundred feet above tide.

At Gasport, six and a half miles east of Lockport, through limestone, nearly five hundred feet above tide.

If Lake Erie is five hundred and sixty-five feet above tide, we have this same gas issuing from strata from fifteen hundred to two thousand feet in thickness, and not less than four hundred miles in extent.

The above facts afford the most convincing proofs that the evolution of this gas is no evidence of the existence of coal at any moderate depths below the surface; unless, indeed, the views which are at present entertained concerning the geological situation of this mineral are entirely erroneous. And although carburetted hydrogen frequently has its origin in beds of bituminous coal, the facts which have just been detailed tend to show that its occurrence does not necessarily depend upon such an agency.

NITROGEN SPRINGS.

Springs evolving nitrogen gas, are by no means common in the State of New-York. A few, however, occur, which possess considerable interest in consequence of the quantity of that gas which they give out. There are, moreover, some springs to be noticed under another head, among the gaseous constituents of which is an air that contains a larger proportion of nitrogen than is present in the atmosphere.

Columbia County. The most remarkable nitrogen spring in the State, is the one at Lebanon in this county. This spring is about ten feet in diameter and four feet deep, and discharges a large amount of water. Its temperature is uniformly 73° F., while that of all the other springs in the vicinity is 52°. The water is quite tasteless. Its specific gravity is scarcely above that of distilled water, as it holds only a minute portion of saline matter in solution. According to Dr. W. Meade, a pint of this water contains 1.25 grains of saline matter,* viz:

Chloride of calcium,	0.25 grains.
Chloride of sodium,	0.44 "
Carbonate of lime,	0.19 "
Sulphate of lime,	0.37 "

Bubbles of air continually rise through the crevices of the rock at the bottom of this spring, which, ascending rapidly through the water, occasion an incessant agitation, and appear to break on the surface without being at all absorbed by the water.† This air is given out in the proportion of about five cubic inches from a pint of the water; and it consists, according to the experiments of Prof. Daubeny of Oxford, of 89.4 parts of nitrogen, and 10.6 parts of oxygen, in the hundred. This is equal to nearly fifty parts atmospheric air, and fifty parts pure nitrogen, in the hundred. Prof. Daubeny could not detect any carbonic acid in the gaseous matter given out by this spring.

So large is the quantity of water at the Lebanon Springs, that advantage has been taken of it, and of the elevation of the ground, not only to supply all the baths, but to turn two or three mills erected in the vicinity.

Rensselaer County. Springs evolving nitrogen gas are also found in the southeast corner of the town of Hosick, six miles southeast of the village of Bennington in Vermont. Of these, Prof. Eaton gives the following description: "There are three springs comprised within about four or five acres of ground. The quantity of pure nitrogen gas which issues in the form of bubbles from these springs, is incalculable. The gas does not seem to be combined with the water, but to issue from the gravel beds beneath the water of the springs; and

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* *Chemical Analysis of the Waters of New-Lebanon, N. Y., with Observations on their Medicinal Qualities, and principally as a Bath.* By William Meade, M. D.

† Mr. Mather states that this spring rises from near the junction of the talcose slate with the limestone; and he adds, that there are some traces of a fault in the vicinity. *New-York Geological Reports*, 1838.

we have no good reason for saying that the gas is confined to the bed of these springs. It may constantly issue from the dry parts of the soil in their immediate vicinity, and become manifest only where the water covers the soil, by bubbling through it. By pressing upon a surface of the gravel equal to five or six inches square, a quart of the gas may be collected in an inverted jar or bottle, in ten seconds."*

Seneca County. At Canoga in this county, there is a pool nearly twenty feet in diameter, from which nitrogen gas is abundantly evolved. The force of the water is so great that the pool is kept in violent ebullition, which, with the constant escape of the gas, gives it the appearance of a boiling cauldron. No deposit of any kind is left by the water. Its temperature is about 40° F.†

Franklin County. To the above, I can add only the springs of Chateaugay in this county. These springs rise from a white sand, and from them there is a flow of water sufficient to turn a mill wheel. The water is quite cold, but bubbles of nitrogen gas continually rise from the bottom.‡ It must also hold in solution some calcareous salts, as tufa is abundantly formed in the vicinity.

The origin of nitrogen gas in springs has been referred by some to the decomposition of animal matter in the interior of the earth; but a much more consistent theory is that which ascribes it to certain processes going on in the interior of the earth, which occasion the abstraction of oxygen from common air.§

ACIDULOUS OR CARBONATED SPRINGS.

By acidulous or carbonated waters, I mean those which are charged with a considerable proportion of carbonic acid, giving to them a peculiar sparkling character, and which also contain some alkaline carbonate as one of their constituents.

The springs belonging to this class in our State, although not very numerous, are several of them quite celebrated, and have been for a long time great centres of attraction and sources of wealth.

Saratoga County. At the head of the list, are undoubtedly to be placed the waters of the *Saratoga Springs*. These, in consequence of the high reputation which they have enjoyed, have often been made the subjects of chemical examination; and on this account, it will be the less necessary for me to devote much time to them in the present report. Indeed, were it not that I am desirous of presenting a general view of our carbonated waters, I should be content, so far as those of Saratoga are concerned, with the simple reference to the detailed and valuable description published by Dr. Steel.‖

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* *Geological Survey of Rensselaer County, N. Y.* p. 29.

† Hall. *New-York Geological Reports*, 1839. ‡ Emmons. Ibid. 1837.

§ Daubeny. *Report on Mineral and Thermal Waters*, in the Report of the British Association for the Advancement of Science, for 1836.

‖ *An Analysis of the Mineral Waters of Saratoga and Ballston, with Practical Remarks on their Medicinal Properties, etc.* By John H. Steel, M.D. 1831.

One of the earliest notices of these springs, is that of Samuel Tenny, contained in the second volume of the *Memoirs of the American Academy of Arts and Sciences.* In 1793, Dr. Valentine Seaman published a dissertation on the mineral waters of Saratoga, and indicated, with as much accuracy as the state of chemical analysis then admitted, their chemical composition.* But the later analyses of Prof. J. F. Dana† and Dr. Steel are more exact, and have given us a more correct knowledge of their constituents.

It is well known that there are a number of springs at Saratoga, the waters of which bear a general resemblance to each other; but owing either to some difference in the chemical composition, or to the influence of fashion, some particular spring has always been more celebrated than all the rest. Such has been the case with the Congress Spring, and the chemical composition of its waters will unfold to us that of several others found in its immediate vicinity.

The following is the composition of a pint of the water from the Congress Spring, according to the analyses of Prof. Dana and Dr. Steel:

	Dana.	Steel.
Chloride of sodium,	54.30 grains.	48.13 grains.
Hydriodate of soda,		0.44 "
Carbonate of soda,	2.00 "	
Bicarbonate of soda,		1.12 "
Carbonate of magnesia,	4.00 "	
Bicarbonate of magnesia,		11.97 "
Carbonate of lime,	18.00 "	12.26 "
Carbonate of iron,		0.63 "
Silica,	trace, with iron.	0.19 "
Hydrobromate of potassa,		trace.
	78.30 grs.	74.74 grs.

	cubic inches.	cubic inches.
Carbonic acid gas,	39.10	39.00
Azote,	0.90	
Atmospheric air,		0.87
Gaseous contents,	40.00	39.87

According to Prof. Daubeny, the temperature of this spring is 51° F., while that of the New Congress Spring and Hamilton Spring is 49° 5′. This, he thinks, is three or four degrees above the mean temperature of the earth at this place. He also states, that while the gaseous contents of the groups of springs at Saratoga and Ballston consist chiefly of carbonic

* See also some remarks by the same author, upon the analysis of Ballston water by Prof. Caizalet of Bordeaux. *Medical Repository*, XI. 253.

† *New-York Medical and Physical Journal*, VI. 66.

acid, they contain also a small residuary portion of air, in which nitrogen exists in larger quantity than in the atmosphere.

Walton or *Iodine Spring*. During the year 1839, a spring was discovered a few rods north of the High Rock Spring, which received this name. According to Dr. Emmons, who analyzed the water, the following is the composition in one pint:

Chloride of sodium,	23.37 grains.
Carbonate of magnesia,	9.37 "
Carbonate of lime,	3.25 "
Carbonate of soda,	0.25 "
Carbonate of iron,	0.12 "
Hydriodate of soda,	0.48 "
	36.84 grs.

	CUBIC INCHES.
Carbonic acid gas,	41.25
Atmospheric air,	0.50
	41.75

The peculiarities of this water are, the absence of oxide of iron, and the large proportion of iodine which it contains.

Another spring was discovered near the Pavilion, which exceeds all the other springs at Saratoga in the amount of carbonic acid gas which it evolves, although the proportion of its saline constituents is less than that of the Congress Spring. So copious is the flow of gas, that by the usual manipulation, a tumbler or bell glass may be quickly filled with it.

The water of the *Union Spring*, recently opened, according to the published analysis of Dr. James R. Chilton, contains a larger proportion of saline ingredients than any of the preceding.

Ballston Springs. The springs at Ballston are mostly situated in the valley of the stream which passes through the village. The bed of this stream is slate, although it is by no means certain that the carbonated waters have their origin in this rock.

An interesting group of springs occurs in this village near the bathing house. Here we have the *United States Spring*, which is acidulous; at a distance of nineteen feet is the *Fulton Chalybeate Spring;* while in an opposite direction, and within twelve feet of the former, is the *Franklin Sulphur Spring*. Thus there are three springs, differing considerably in their composition, within a few feet of each other. The United States Spring is highly charged with carbonic acid gas, while the others contain only a small portion of it. The temperature of this spring is 50° F; and from all the information which we possess, it does not seem to vary perceptibly during the year. The water has a specific gravity of 1.00611. The following is the composition of one pint, according to my analysis:

Chloride of sodium,	53.12 grains.
Carbonate of soda,	2.11 "
Carbonate of magnesia,	0.72 "
Carbonate of lime, with a little oxide of iron,	3.65 "
Sulphate of soda,	0.22 "
Silica,*	1.00 "
	60.82 grains.

Carbonic acid gas, 30.50 cubic inches.

Low's Well has a composition similar to the preceding, but the amount of saline matter is less. Its specific gravity is 1.02548; temperature, 50° F. *Park Spring*, situated in the rear of the Village Hotel, has also nearly the same constituents, but the oxide of iron is in much larger proportion than in any of the waters in this vicinity.

From several of the springs at Ballston, as well as at Saratoga, there is a discharge of gas in larger or smaller bubbles, which does not seem to be associated with the water. At the Park spring, minute bubbles of gas are continually rising through the water, but at an interval of about a minute, the whole well is agitated by the evolution of a comparatively large bulk of the gas. This gas, which is in all cases nearly pure carbonic acid, also rises in great abundance through the water of a well near Low's spring, and in various places in the valley of the stream. Some years since, there was a very remarkable and indeed almost volcanic discharge of it near the old factory, which threw up the water of the creek several feet into the air; but the gas soon diminished greatly in quantity, and can now be observed rising only in small bubbles through the bed of the stream.

From these facts, it is evident that here, as at Saratoga, there are certain agencies in operation which cause an abundant evolution of carbonic acid, a part of which has been originally held in solution by the water, but another and perhaps much the largest part is an independent stream of gas discharged in the form of a solfatara or gaseous spring. That this gas originates at great depths, and rises freely through the crevices in the rock, is rendered probable from its alternately breaking out and disappearing at points somewhat distant from each other. And perhaps the opinion of Berthier may here be applied, viz. that the water of the spring is forced up by the elasticity of the confined gas.

The phenomena presented at Ballston, so far at least as the evolution of the gas is concerned, are quite analogous to those noticed by Brandes and Kruger, in their account of the mineral waters of Pyrmont, that the extrication of this gas is by no means limited to the spot from whence the chalybeate springs of that watering place arise, but is observed for some distance round, wherever fissures, natural or artificial, exist. Thus a cavity having been made by some workmen, for quarrying stone, it was found that the air became charged with from thirty-

* This water probably contains both iodine and bromine in some form of combination, but the quantity upon which I operated was too small to admit of separating them, and determining their relative proportions.

six to forty-eight per cent. of carbonic acid, which rose in the cavern to different heights at different times.*

In general, the occurrence of carbonic acid in these waters is to be ascribed to the existence of large quantities of it held in solution by water at great depths, and therefore under enormous pressure; or by the gas itself being kept by the same agency in a liquid form, until, by the removal of the pressure, it assumes the gaseous state, and is thus disengaged.† Mr. Mather suggests that the mineral qualities of the Ballston waters originate at the contact of the slate with the Trenton limestone, which he thinks is not more than fifty feet below the level of the valley.

Washington County. *Reed's Mineral Spring*, in South Argyle, near the Moses Kill, is an acidulous carbonated water, somewhat similar to the Saratoga waters, but it contains less gas. According to Mr. Mather, some bubbles of carbonic acid rise from the water, the taste of which is distinctly acidulous, but it does not sparkle.‡

Albany County. A spring similar to those of Ballston and Saratoga, was discovered in the city of Albany in 1827. Messrs. Boyd & McCulloch, the proprietors of a brewery in Ferry-street, in the hope of obtaining pure water on the premises, in sufficient quantity for the supply of their establishment, commenced boring upon the plan of Mr. Disbrow, during the year 1826. After descending to the depth of about four hundred and eighty feet, the water, which rose nearly to the surface, was found to have a saline taste and a sparkling appearance. At the request of the proprietors, I analyzed a portion of this water, and found its composition to be as stated below. There was also observed, rising through the water, an inflammable gas, which was found to be carburetted hydrogen. The boring was continued about six hundred feet through the slate rock, and the flow of carbonated water and inflammable gas continued. The obtaining of fresh water being therefore considered hopeless, a tube was sunk to prevent the admixture of the carburetted hydrogen with the mineral water, and an apparatus constructed for raising a supply of the latter.

Subsequently, Mr. McCulloch commenced boring a few rods from this place, when, at about the same depth, the vein of mineral water was again struck. It was also accompanied by the inflammable gas, as in the former case. And to add to the interest of the locality, it was, moreover, found that at the depth of about thirty feet from the surface, a vein of water was crossed which was highly charged with sulphuretted hydrogen gas. We have then in the same slate formation, though at different depths, sulphuretted hydrogen, carburetted hydrogen and carbonic acid gases, abundantly evolved.

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* See Professor Daubeny's *Report on Mineral and Thermal Waters.*

† Bischof concludes a paper on the "Subterranean course of water, etc." with the following remarks: "In order then to explain the absorption of carbonic acid gas by the water, and the subsequent decomposition of the component parts of this carbonic-acid-water, to explain in one word the formation of a mineral spring, rich in carbonic acid, we have only to assume, that in the interior of the earth, narrow canals coming from beneath, join large ones; that they bring carbonic acid gas, and that the larger canals are filled with water." *Edinburgh New Philosophical Journal*, XVIII. 246.

‡ *New-York Geological Reports*, 1841.

Another curious fact noticed at the locality now under consideration was, that when the pump in the present Mineral Garden was put in operation, the level of the water in the other well was soon reduced, and it was at length rendered entirely valueless. It may hence be inferred that there is here a subterranean vein of mineral water; and from the general similarity in its composition to that of the springs of Saratoga and Ballston, it is not improbable that this vein is of considerable extent. Nor would it be at all surprising if carbonated water should be found by boring to a sufficient depth at any place in the range from Albany to Saratoga, where its discovery should be thought of sufficient importance to warrant the necessary expenditure.

The occurrence of carbonic acid in all these waters, has been ascribed with some plausibility to the reciprocal action and decomposition of the sulphuret of iron and carbonate of lime, contained in the strata of argillite, in which they exist. But if this view is correct, it is not easy to account for the absence of sulphate of lime, a salt so generally found in mineral springs, and which would, by this supposed process, be abundantly formed; and it leaves still unaccounted for, the singular fact, that in the same rock formation, different gases are given out at different depths, and appear to be, as far as their origin is concerned, entirely independent of each other. Thus at the Albany spring, sulphuretted hydrogen rises from about thirty feet from the surface, and when a tube is sunk below this, the water contains no admixture of this gas; again, at the depth of about four hundred feet, the carburetted hydrogen appears, and lastly, the carbonated water. We must, therefore, refer the production of these gases to more general, and probably more effective agencies.

It may be proper to state, as it may throw some light upon this interesting subject, that at the Albany spring a tube was sunk into the boring about a hundred feet, and to it was attached a pump for raising the water into a cistern. When the pump has been worked for some time, the sulphur water sinks below the surface of the ground, and again appears when the pumping has ceased. After the mineral water is discharged from the cistern, and the pressure is thus relieved, the inflammable gas flows out. It burns with a reddish white flame, blue at the base. Neither this gas nor the water contains the least portion of sulphuretted hydrogen.

The specific gravity of the Albany mineral water at 60° F. is 1.00900; temperature, 51° to 52°. The following is its composition, in one pint — the first analysis is by Dr. Meade;* the second by myself: †

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* *American Journal of Science*, XIII. 145.

† The portion of this water which I analyzed, was obtained from the boring, soon after its mineral character was first noticed. The amount of carbonate of iron obtained from it was not, as I have since learned, all chemically combined. I have accordingly made the proper correction.

	I.	II.
Chloride of sodium,	63.00 grains.	59.00 grains
Carbonate of soda,	5.00 "	5.00 "
Carbonate of lime,	4.00 "	4.00 "
Carbonate of magnesia,	2.00 "	1.50 "
Carbonate of iron, (with a little silica),	1.00 "	1.00 "
Chloride of calcium,		0.50 "
	75.00	71.00
	CUBIC INCHES.	CUBIC INCHES.
Carbonic acid gas,	28.00	
Gaseous contents,		26.00

Oneida County. *Halleck's Spring*, in this county, appears to deserve a notice under the head of carbonated springs. It is situated about half a mile northeast of the village of Hampton, in the town of Westmoreland, and was the result of a boring into a solid rock of a hundred and six feet. The following is the composition of one pint of this water, according to the analysis of Prof. J. Noyes, formerly of Hamilton College:

Chloride of sodium,	78.00 grains.
Chloride of calcium,	13.00 "
Chloride of magnesium,	4.00 "
Sulphate of lime,	5.00 "
	100.00 grs.

This spring evolves carburetted hydrogen in considerable quantities, together with a minute portion of carbonic acid. The composition of the water is quite similar to that of the weak brine springs, to which it perhaps more properly belongs.

The following springs, which may be arranged under this division, deserve only a brief notice.

In Rensselaer County, about a mile west of the village of Sandlake, there is a strong and copious chalybeate spring, which issues from the gravel.

In Essex County, near Crown Point, is a spring which, according to Dr. Emmons, has a specific gravity of 1.014, and 1000 parts of which contain 18.78 parts of saline matter. This saline matter consists principally of sulphate of magnesia, with a portion of sulphate of lime.*

In Greene County, there is a strong chalybeate spring near Catskill. Several of a similar kind occur in the Counties of Dutchess, Columbia and Delaware. It is probable that the oxide of iron which they deposit has originally been held in solution by carbonic acid.

* Emmons. *New-York Geological Reports*, 1838.

It may also be added, that in Cliff-street in the city of New-York, a mineral spring was some years since opened, which is more nearly allied to the waters of this class than of any other. According to the analysis of Mr. G. Chilton, this water is more complex in its composition than any hitherto found in the State. A pint of it was found to contain 18.74 grains of saline matter, and 9.14 cubic inches of carbonic acid and atmospheric air.*

SULPHURETTED OR SULPHUREOUS SPRINGS.

Sulphuretted springs, or such as have their waters charged with sulphuretted hydrogen gas, are of very frequent occurrence in this State. Indeed, there is scarcely a single county in which they are not found. They may, of course, always be known by their unpleasant odour; and if strongly charged with the gas, by the effect which they have of blackening silver and a solution of sugar of lead.

The peculiar character of these springs is, in some instances, owing to the pure sulphuretted hydrogen gas which these waters hold in solution, and evolve upon coming into contact with the atmosphere. In some cases, however, they preserve their character after the water has been boiled; which indicates the presence of a hydrosulphate, or, as it may be more properly termed, a *hydrothionate;* of which the common is, perhaps, the hydrothionate of lime.

Valley of the Hudson. Commencing at the southern part of the State, sulphureous springs are found at short intervals from near Sing-Sing in Westchester county, to Fort Miller in Washington county, a distance of nearly a hundred and fifty miles. They occur on both banks of the Hudson, and usually rise through the strata of glazed black slate which is found throughout nearly the whole of this extent. Some of these deserve to be noticed.

The *Chappequa Spring*, four miles northeast of Sing-Sing, issues from a cleft in the rock near the base of a hill about two hundred feet in height. The water, as it rises from the rock, is transparent, but in its course deposits a reddish yellow powder. The salts held in solution are said to be sulphate of lime, chloride of calcium, and the muriate of iron and manganese. The water is supposed to possess medicinal properties, similar to those usually ascribed to sulphur springs.

In Orange County, a sulphur spring occurs near the village of Newburgh. One or two others have also been noticed in this county.

In Dutchess County, there is a sulphur spring one and a quarter mile north-northwest of Ameniaville; while in the adjoining county, Columbia, Mr. Mather has noticed one about a mile and a half north of Kinderhook, and several in the adjacent marsh; another, a mile east of Miller's tavern, near the line of Claverack and Ghent; another, a mile east of Mr. Livingston's, Oakhill; another, on McNaughton's farm, between Lebanon Springs and the Shaker village.

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* The entire analysis will be found in the *American Journal of Science*, XVIII. 346.

In Ulster County, a sulphur spring occurs near the base of the Shawangunk mountains, about a mile west of Springtown in the town of New-Paltz. Gas rises, at intervals of a few seconds, from the bottom of this spring, and the water is supposed to possess valuable medicinal properties.

In Greene County, there is a sulphur spring rising from the slate of the Catskill mountain series, about three quarters of a mile west of Greenville, and within a few miles of the Hudson; another, two miles west of the village of Catskill; and still another, issuing from the clay beds about four miles west of Athens, in a valley at the base of the water lime group of the Helderberg limestone series.*

In Albany County, there is a sulphur spring at Coeymans Landing; one in Guilderland; one in Rensselaerville, in the valley of Fox's creek, three miles from Preston Hollow; one in Wendell's Hollow, near the city of Albany; and one in the town of Watervliet, &c.

In Rensselaer County, we have the old Harrowgate Springs near the village of Greenbush; one near the north end of the city of Troy, besides others of less importance.

In Saratoga County, numerous springs of this kind are found.

The springs just enumerated are usually impregnated with the sulphuretted hydrogen in sufficient quantity to change the colour of the solution of acetate of lead; but, in some instances, the quantity is so small as to be perceptible only by its odour. The waters generally yield, upon evaporation, sulphate and carbonate of lime.

Northern New-York. Some interesting sulphur springs occur in the northern parts of the State. Thus in the town of Beekman in the County of Clinton, is a spring of this kind, which has acquired some celebrity. The water is said to contain sulphur, iron and carbonic acid.

In St. Lawrence County, there are several sulphur springs. Of these, probably the most important is that which occurs about a mile from Massena, on the banks of the Racket river. The water of this spring is strongly charged with sulphuretted hydrogen. According to Dr. Emmons, the solid matter which it holds in solution is chloride of calcium or magnesium, or both. There are other springs of a similar kind on the banks of the same stream, which are more or less resorted to by the inhabitants of this and of the adjacent counties.

Sulphur springs are often met with in the County of Lewis; but none of them, I believe, are of much importance.

Western New-York. In the western part of the State, and especially in the district adjoining the Erie canal, sulphur springs are of still more frequent occurrence than elsewhere, and at the same time are also more interesting in their nature. It is further worthy of remark, that in general, the strata of rocks through which they rise are entirely different from those with which they are associated on the Hudson river.

Schoharie County. Near the village of Leesville, in the town of Sharon, is a spring largely impregnated with sulphuretted hydrogen, which has acquired a high reputation for the

* Mather. *New-York Geological Reports*, 1840 and 1841.

cure of those diseases which are known to be relieved by waters of this description. It is represented as having the characters of the Virginia springs. Its waters, flowing over vegetable substances, encase them in a covering of sulphur. So abundant is the evolution of the gas from this spring, that metals are quickly tarnished in its vicinity. Mr. Gordon states, that at a quarter of a mile from its source, though flowing with fresh water, it preserves its distinctive character, to a ledge of rocks, over which it falls perpendicularly sixty feet, and has a volume sufficient to drive a grist mill.* An extensive building for the accommodation of visiters has recently been erected here, and the water has been analyzed by Dr. J. R. Chilton of New-York. The following are the results, reduced to one pint:

Sulphate of magnesia,	2.65 grains.
Sulphate of lime,	6.98 "
Chloride of sodium,	0.14 "
Chloride of magnesium,	0.15 "
Hydrosulphuret of sodium, Hydrosulphuret of calcium, Extractive matter,	0.14 "
	10.06 grains.

Sulphuretted hydrogen gas, 1 cubic inch.

It is worthy of remark, as perhaps throwing some light upon the origin of this water, that sulphate of lime, in small but perfect crystals, is found near the spring in considerable abundance.

In Otsego County, north of Cherry-Valley, below the falls, are several sulphur springs, which, according to Mr. Vanuxem, issue from the drab limestone, and deposit tufa and sulphur. Some of the springs in this county are in repute, and considerably resorted to.

Prof. Eaton has stated that sulphuretted hydrogen gas issues from a spring on the Otsquago creek, ten miles south of Fort-Plain on the Erie canal. The gas burns along the surface of the water, with a bright red flame by daylight. It issues from the water continually, at the rate of a little more than a gallon in a minute.†

In Herkimer County, a sulphur spring has been noticed by Mr. Vanuxem, near Remington's forge, not far from the village of Mohawk; and which, according to that gentleman, rises immediately above the millstone grit.

Oneida County. We come next to the sulphuretted springs of this county, some of which possess a high degree of interest. One of them is the *Verona Spring*, fourteen miles from Utica. Its water has been analyzed by Prof. Noyes; the following is the composition in one pint:

Chloride of calcium, with chloride of magnesium,	8.50 grains.
Sulphate of lime,	7.50 "
Chloride of sodium,	90.00 "
	106.00 grains.

The water is supposed to be nearly saturated with sulphuretted hydrogen gas.

* *Gazetteer of the State of New-York.*

† *American Journal of Science*, XV. 235.

Saquoit Springs. In the town of Paris, in the same county, nine and a half miles south of Utica, are the Saquoit mineral and burning springs, the waters of which are highly charged with sulphuretted hydrogen, and contain the chlorides of sodium and magnesium in considerable quantities, together with a little sulphate of lime and a trace of iron. The gas rises from the water in such abundance as to allow of its being conducted through tubes, and to be kept constantly burning.

Madison County. The most important sulphur springs in this county, are those in the vicinity of the village of Chittenango. They are situated in the valley of the Chittenango creek, and issue from the hill of calciferous slate, which here forms its eastern boundary. One of these springs is on the lands of the late John B. Yates, Esq., about a mile south of the village. The temperature, at the time of my visit, was 49° F. Its water is limpid, and emits a strong odour of sulphuretted hydrogen, with which it is sufficiently charged to blacken silver and the salts of lead. Its specific gravity is 1.00341. The following is the composition in a pint, according to my analysis :

Carbonate of lime,	0.88 grains.
Sulphate of soda,	1.66 "
Sulphates of lime and magnesia,	12.75 "
Chloride of sodium,	0.14 "
Organic matter,	trace.
	15.43 grains.

Besides the sulphuretted hydrogen, the water contains a small portion of carbonic acid gas.

Another interesting spring is found on the farm of Judge Warner, about two miles south of the village. The water at this place rushes out of a crevice in the rock, at the rate, according to the measurement of Mr. Warner and myself, of about thirty-eight gallons in a minute. When fresh from the spring, it has an opaline or milky appearance, and a strong sulphureous odour. This milkiness I found it to retain, even after eighteen hours exposure to the air. Upon being boiled, the water becomes clear, and a whitish precipitate is deposited, which is principally sulphate of lime ; to which, indeed, its peculiar appearance may be ascribed. All the sulphur springs which I have thus far examined, with this single exception, are perfectly limpid ; and Mr. Warner has given this the characteristic name of the Chittenango White Sulphur Spring.

The temperature of this spring is about 49°. Its water is so strongly charged with the sulphuretted hydrogen gas, that its odour is not only perceptible at a considerable distance, but its peculiar chemical effect is to be observed upon the bathing and lodging houses in the vicinity. Its specific gravity is 1.00254. The following is the composition in a pint :

Carbonate of lime,	1.33 grains.
Sulphate of lime,	8.22 "
Sulphate of magnesia,	3.11 "
Chloride of sodium, and vegetable matter, a minute quantity.	
	12.66 grains.

Like the preceding spring, it contains a portion of carbonic acid, which holds the carbonate of lime in solution. In the vicinity of each of them are to be found leaves, twigs and pieces of wood, covered with a whitish incrustation, which on examination proves to be free sulphur, together with sulphate and carbonate of lime.

The waters just described are highly esteemed in many cases of disease; and their location is so eligible, that I do not doubt, that when they are better known, they will be much resorted to. And here it may be remarked, that the village of Chittenango is, on several accounts, a point of considerable interest. In addition to the sulphuretted and petrifying springs found in the immediate vicinity, there are valuable beds of gypsum, extensive deposits of excellent water limestone, and of grey limestone, the last of which is one of the most beautiful and durable building materials.

Onondaga County. The sulphureous springs of Onondaga county are more numerous than those of Madison, or at least a greater number have already been made known.

About a mile from Manlius Square are three springs very near to each other, all of which are feebly charged with sulphuretted hydrogen. They have also a slightly saline taste, and have acquired some reputation in the vicinity.

Two miles east of Manlius Centre is a lake or pond, known by the name of Lake Sodom or Green Pond. This pond is about a mile and a half in length, and half a mile in breadth at the widest part. The water is of a deep green colour, which is probably owing to the partial decomposition of the sulphuretted hydrogen which it holds in solution. The depth of the water gradually increases, as we proceed from the northern outlet, from twenty-five, to a hundred and sixty-eight feet; the latter depth continuing for some distance around what is probably the centre of the basin. Water drawn from the depth of one hundred and sixty-eight feet, was found to be strongly charged with sulphuretted hydrogen. On being afterwards tested, it blackened nitrate of silver powerfully, and gave copious precipitates with solutions of oxalate of ammonia and muriate of barytes, indicating the presence of sulphuretted hydrogen and sulphate of lime. Its specific gravity was scarcely above that of distilled water, and it contained not even a trace of oxide of iron.

Thus we have here a natural sulphur bath, of a mile and a half in length, half a mile in width, and one hundred and sixty-eight feet in depth; a fact which exhibits, in a most striking manner, the extent and power of the agency concerned in the evolution of this gas.

Sulphuretted hydrogen gas is evolved in great quantities in the immediate vicinity of the salt springs at Salina and Syracuse. On the grounds of Mr. E. F. Wallace of Syracuse, there rises out of the earth in the bed of a small ravine, water strongly charged with this gas, and containing also some carbonic acid, together with a large proportion of saline matters. This spring is situated about forty rods from the Syracuse brine well. Its water is perfectly transparent, blackens salts of lead, but has scarcely more than a trace of oxide of iron. Its specific gravity is 1.01426. The composition in one pint is as follows:

Carbonate of lime, with minute portions of oxide of iron and silica,	1.74 grains.
Sulphate of lime,	7.97 "
Chlorides of calcium and magnesium,	1.07 "
Chloride of sodium,	122.86 "
	133.64 grs.

Gaseous substances, sulphuretted hydrogen and carbonic acid.

Another spring, quite similar in its character to that just described, is found on the marsh, a short distance from the Salina well, and about a mile from the preceding. The composition of the Salina sulphur spring, in a pint, is as follows:

Carbonate of lime, with minute portions of oxide of iron and silica,	0.58 grains.
Sulphate of lime,	11.18 "
Chlorides of calcium and magnesium,	0.96 "
Chloride of sodium,	173.69 "
	186.41 grs.

Gaseous matters, sulphuretted hydrogen, with a minute portion of carbonic acid.

These waters, therefore, seem to be weak brines, charged with sulphuretted hydrogen; and it is a fact of some interest in connection with the history of the brine springs of this region, that the gas just mentioned is also evolved in considerable quantity by many of the pools and small collections of water found in their vicinity. To this may be ascribed, with much plausibility, the origin of the sulphate of lime, so constantly associated with the common salt in all the Onondaga brines.

In the town of De Witt, three miles northeast of Syracuse and a mile north of the Erie canal, are the *Messina sulphur springs*. They are situated in a ravine, similar to that in which are found the springs of Manlius and Chittenango; and they rise through a limestone formation, on the surface of which are every where found masses of calcareous tufa. The temperature is uniformly 50° F. The water has a strong sulphureous taste, but is not so highly charged with the gas as that of other springs. When it has been exposed to the air for a few hours, it becomes milky, no doubt in consequence of the decomposition of the sulphuretted hydrogen, and the subsidence of some of the less soluble salts. The whitish crust usually found near springs of this class, is observable here, and the tufa so abundantly met with undoubtedly owes its formation to waters similarly constituted. I need scarcely add, that this water is used with good effects in many diseases. Its specific gravity is 1.00305; and its composition, in a pint, is as follows:

Carbonate of lime,	1.85 grains.
Sulphate of lime,	8.55 "
Sulphate of magnesia,	1.36 "
Chloride of calcium,	1.33 "
	13.09 grains.

The number of springs belonging to the class which I am now considering, seems to increase as we proceed westwardly, so that it is scarcely possible to do more than to notice briefly some of the most important of them.

Cayuga County. In this county are several sulphureous springs. One of these is in the town of Sennett, two miles north of the village of Auburn. Another, which has also acquired some reputation, is situated about four miles west of Auburn, on the farm of Mr. Nelson Van Ness; it is called West-Auburn Spring. One pint of the water, according to the analysis of Dr. Chilton, contains the following substances, viz:

Sulphate of lime,	15.00 grains.
Sulphate of magnesia,	3.20 "
Chloride of magnesium,	0.25 "
Chloride of sodium,	0.75 "
	19.20 grains.

Sulphuretted hydrogen gas, 1.5 cubic inches.

At Spring Mills, on the eastern shore of Cayuga lake, a sulphuretted water is said to issue from the earth in quantities sufficient for turning a grist mill. The water is perfectly limpid; and notwithstanding the large stream which is continually flowing, the taste and odour of sulphuretted hydrogen are very strong.

Wayne County. Although there are several sulphur springs in this county, none of them have as yet acquired much notoriety. Some rise in Brown's mill pond, about a mile and a half south of Newark. The water running from this pond deposits sulphur, and sulphuretted water issues from the bank at the road opposite the dam, and forms a whitish deposit. Another spring, issuing from the bituminous limestone, is found about half a mile northeast of Marion Centre, and is resorted to by visiters. In addition to these, weak sulphur springs are reported to occur on Salmon creek, near the forge in Sodus; one or two at or near Palmyra, and one in the village of Clyde.*

In Seneca County, several sulphureous springs are noticed in the water lime series, but none of them are of much importance.

Monroe County. Sulphureous springs are found in great numbers in this county. Among them may be mentioned those of Rochester, Mendon, Gates and Pittsford; at all of which there are bathing houses, and ample accommodations for visiters. At the village of Ogden, in the town of the same name, one and a half mile south of Spencer's Basin, is a spring, probably more highly charged with the gas than any other in the county.

In the city of Rochester, on the east bank of the Genesee, is Longmuir's sulphur spring, the waters of which are much employed by the inhabitants. It rises through a boring of two

* Hall. *New-York Geological Reports*, 1838.

hundred feet in depth, which was commenced by the Messrs. Longmuir, in the hope of obtaining a supply of pure water for their brewery in the immediate vicinity. One of the proprietors informed me that the evolution of sulphuretted hydrogen was first observed at the depth of fifty feet below the surface, which would be within the strata of calciferous slate.

The temperature of Longmuir's spring is usually 52° F. The water, when heated to about 100°, deposits sulphur and carbonate of lime. The specific gravity is 1.00407. One pint of this water contains

Carbonates of lime and magnesia, with a trace of oxide of iron,	1.48 grains.
Chloride of sodium,	6.52 "
Sulphate of soda,	6.99 "
	14.99 grs.

Gaseous contents, sulphuretted hydrogen, 2.16 cubic inches, with a small quantity of carbonic acid.

To show how abundantly sulphuretted hydrogen is evolved in this district, it is only necessary to notice the Caledonia springs in the town of Wheatland, where a large volume of water gushes out of the earth, forming a stream nearly one quarter of the size of the Genesee river at Rochester, the whole being slightly impregnated with this gas.

Livingston County. Some of the most interesting and valuable sulphur springs which this State possesses, are found in this county. Those situated near the village of West-Avon, are particularly deserving of notice. Three springs have already been discovered here; and as their chemical composition does not materially differ, it is probable that they exert similar effects on the animal economy.

The first spring is called the *Avon New Bath Spring*, and was discovered by the present proprietor in 1835. Its depth is about thirty-six feet; and the formation through which the water rises, is the calciferous slate, similar to that found at Rochester. The temperature of this spring is about 50° F.; the specific gravity of the water, 1.00356.

One pint of water from the Avon New Spring contains

Carbonate of lime,	3.37 grains.
Sulphate of lime,	0.44 "
Sulphate of magnesia,	1.01 "
Sulphate of soda,	4.84 "
Chloride of sodium,	0.71 "
	10.37 grains.

Sulphuretted hydrogen, 3.91 cubic inches.

The Middle Spring is situated about thirty rods east of the former. Its temperature is 51° F. The following, according to Prof. Hadley, is the composition of a pint of this water :

Carbonate of lime,	1.00 grains.
Sulphate of lime,	10.50 "
Sulphate of magnesia,	1.25 "
Sulphate of soda,	2.00 "
Chloride of sodium,	2.30 "
	17.05 grains.
Sulphuretted hydrogen,	12.00 cubic inches.
Carbonic acid,	5.60 "
Gaseous contents,	17.60 cubic inches.

The third or Lower Avon Spring is similar in its composition to the preceding. It is remarkable for the large volume of water which it discharges. This has been estimated to be equal to fifty-four gallons in a minute, and I apprehend that this is not far from being correct.

The waters of all the Avon springs give out powerfully the odour of sulphuretted hydrogen, and have a strong saline taste. They speedily blacken silver and the salts of lead. The solution of arsenious acid is but slightly altered by it, until after the addition of an acid; from which I infer that a portion of the sulphuretted hydrogen is in a state of combination with some basis.

The situation of the village of Avon in one of the most beautiful and fertile portions of Western New-York, and the valuable medicinal qualities of its springs, conspire to render this one of the most attractive watering places in this State.

Genesee County. In this county, we have, near North-Byron, a sulphureous spring, the gas of which is so copiously given out as to be inflamed; and in the southeast part of the same town, are springs of a similar kind.

A very remarkable locality in this vicinity deserves to be particularly noticed here, as the occurrence is undoubtedly to be referred to the same general agencies which are concerned in the production of sulphuretted hydrogen. I refer to the *Sour Spring*, so called, which exists in the southwest corner of the town of Byron. The acid is produced from a hillock about two hundred and thirty feet long and one hundred feet broad, elevated four or five feet above the surrounding plane. According to Prof. Eaton, the strength of the acid increases in a drought. He states, that when he examined the locality, considerable rain had recently fallen, and the acid in most places was very dilute, but in some it appeared to be perfectly concentrated, and nearly dry in its combination with the charred vegetable coat. In this state it was diffused throughout the whole hillock, which was every where covered with charred vegetable matter to the depth of five to thirty or forty inches, occasioned by the action of the sulphuric acid. Wherever holes were sunk in this hill, the acid accumulated, and also in the depressions of the contiguous meadow grounds.

There is another locality of a similar kind a hundred rods west of Byron Hotel, and two miles east of the former, which is remarkable in consequence of the great quantity of acid.

It is a spring which issues from the earth in sufficient volume to turn a light grist mill. Such an immense laboratory of sulphuric acid is here conducted by nature, that all the water which supplies this perennial stream possesses acidity enough to give the common test with violets, and to coagulate milk. Besides the above, there are said to be several other sour springs in this vicinity.*

I have particularly examined both the liquid acid, and the brownish vegetable matter subjected to its action.

The liquid is transparent and colourless; and in the specimen upon which I operated, had a specific gravity of 1.11304 at 60° F. It reddens litmus powerfully, has an intensely sour taste, causes a dense precipitate when added to muriate of barytes, but is not affected by nitrate of silver. When ammonia is added to the liquid to saturation, a slight precipitate of a reddish colour is the result, and the clear solution is afterwards also slightly affected by oxalate of ammonia. The oxide of iron and lime indicated by the two latter tests are, however, in very small proportion; as is evident from the fact, that when the liquid is evaporated, it leaves only a trifling residuum. It is a nearly pure, though dilute, sulphuric acid, and not a solution of acid salts, as has been supposed; for the bases are in too minute proportions to warrant the latter opinion.

The brownish matter, or *acid earth*, is principally vegetable matter, charred by the action of the acid; but it also contains some silica and alumina, with a minute quantity of lime and oxide of iron. When this matter is boiled in water, a solution is obtained which possesses all the properties of the liquid just described. When heated for some time in a crucible to redness, the acid and vegetable matter disappear, and there remain a little sulphuret of calcium formed by the decomposition of the acid and the lime, a trace of iron, together with the earthy matters above mentioned, I could not detect, either in the liquid or in the solution of the earth, any other salt than those which I have already enumerated; unless, indeed, there should be some sulphate of alumina present.

The occurrence of sulphuric acid in nature, in any thing like the pure form which it here possesses, is of great interest; only a few localities, and these rather doubtful, being hitherto known. In most of these, too, the acid is quite dilute; and the occurrence is, moreover, principally confined to volcanic districts.† An earth, somewhat similar to that found in Byron, is said to exist in great quantities at a village called Daulakie, in the south of Persia, between three and four days journey from Bushire on the Persian Gulf. The natives employ it as a substitute for lemons and limes, in making their sherbets, of which considerable quantities are drank, they being prohibited the use of wine. On analysis, the acid was found to be the sulphuric, and this was united to iron; the solution in boiling water, when evaporated, yielding crystals which seemed to be the acid sulphate of that metal.‡

Acid springs or wells are also found in the town of Bergen, in this county.

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* Eaton. *American Journal of Science*, XV. 239.

† See *Gairdner on Mineral and Thermal Springs.*

‡ *Philosophical Magazine for* 1824.

Ontario County. There is a locality somewhat similar to that in Byron, at Clifton Springs, twelve miles northwest of Geneva. The acid may be extracted from the water, while the moss and other vegetables over which it passes become at length encrusted with sulphur. This locality was noticed at a very early period, by one whose name is identified with the history of the physical sciences in this country, and whose great acquirements gave him a conspicuous place among his cotemporaries. "Here," says he, "are several springs, which discharge their waters, and give rise to calcareous as well as sulphureous deposits, which collect on the stones and other bodies wherever the current is gentle or approaches to stagnation. The water, as it issues from the springs, is perfectly transparent; but it soon becomes opaque, and of a yellowish colour. At a short distance from this are other sulphureous oozings; and the sulphur has gathered, until a sort of marsh, perhaps ten rods in diameter, has been formed."*

At the outlet of Canandaigua lake, several sulphuretted springs flow from the limestone formation, and some of which are resorted to for medicinal purposes. The depositions of sulphur are extensive, and are observable on the plants and rocks of the vicinity.

According to Mr. Hall, there are remarkable sulphur springs in the eastern part of Manchester, on the road from Vienna to Canandaigua. The odour of the gas is perceptible at the distance of a quarter of a mile. The water issues from several points at considerable distances from each other, but all at about the same elevation in the rock. From one of these springs, the quantity of water discharged is unusually large. Deposits of carbonate of lime and sulphur are found in the vicinity. All these springs, as well as those which occur at Avon, have their origin in the hydraulic limestone, near its junction with the limestone above.†

In the County of Orleans, there are one or two unimportant sulphur springs near the village of Holley on the canal.

Niagara County. This county is no less abundantly supplied with sulphur springs, than those which have been already noticed. One of these occurs in the town of Pendleton, near the canal. At Lockport, there is a spring from which a large supply of gas was originally discharged. There is also a similar spring, which has acquired some character, two miles from the village of Tonawanda; and in the vicinity of Lewiston, and of the Falls of Niagara, several of them are known to exist.

Erie County. In the Museum of the Albany Institute, is a bottle of water from a spring on Grand Island, presented by the late Surveyor General, Simeon De Witt, labelled "Sulphuric Acid." On testing this water, I found it to redden litmus paper, and to give a dense white precipitate. The specific gravity is 1.00254. The amount of saline matter which it contains is, therefore, exceedingly small.

About four miles from Buffalo, upon the Indian lands, is the *Seneca Spring*, long known by the name of the Deer Lick. There are several of these springs, issuing from the opposite sides of the stream upon which they are situated, and a large quantity of sulphuretted hydro-

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* See Dr. Samuel L. Mitchill's "Tour to Niagara," published in the *Medical Repository*, XIV. 412.

† Hall. *New-York Geological Reports*, 1839.

gen gas is continually evolved from them. According to Prof. Charles U. Shepard, the water of the Seneca spring is strongly sulphureous, but is free from uncombined carbonic acid, and contains notable quantities of the carbonates of lime, magnesia and soda, together with the sulphate of lime.*

Southwestern Counties. We have accounts of numerous sulphur springs in the southwestern range of counties.

In Chenango County, there are several sulphur springs in the town of Pitcher. At some of these, houses were erected for the accommodation of visiters, but they are now seldom resorted to.

In Broome County, the Nanticoke Sulphur Spring was formerly in considerable repute. Similar springs also occur at Bellona in this county.

Sulphur springs are said to exist in Cortland County.

In Tompkins County, there is a spring of this kind in the town of Dryden, ten miles east of Ithaca, which has acquired some celebrity; and another on Six-mile creek, a mile or two southeast of the same village.†

In Tioga County, in the town of the same name, is a sulphur spring; and a similar one occurs in the southwest corner of Barton, on the east bank of Chemung river.‡

In Steuben County, Campbelltown, a village in the northwestern part of the town of Campbell, has a spring of this kind near it, which is said to be remarkably pure, and to emit a stream of air which may be inflamed when confined; and similar springs occur in the towns of Jasper and Urbana, in the same county.

Sulphur springs are occasionally found in the County of Cattaraugus. One upon the land of Judge Leavenworth, near Randolph, is pretty strongly charged. Several have been noticed issuing from the Cashaqua shales, at the base of the cliffs upon the Cattaraugus creek, and the south branch.

Chautauque County. Sulphur springs are here of frequent occurrence, and apparently have some connexion with the issues of carburetted hydrogen gas, for which this county has become so celebrated. In the village of Fredonia, many springs of this kind have been discovered; but they are said to lose their sulphureous character in a short time. This, however, is not the case with those found elsewhere. On the shore of Lake Erie, about a mile east of Van Buren Harbour, a spring, highly charged with sulphuretted hydrogen, issues out of the slate rock, nearly on a level with the lake. The water is cold and clear, but the quantity is not very abundant. The specific gravity is 1.00193 at 60° F.; and it contains minute portions of the carbonate of lime, sulphate of lime and sulphate of soda.

Another spring, of a similar kind, occurs near the sandstone quarries at Laona, a mile south of Fredonia; and others are also found in the town of Sheridan, a mile and a half from Lake Erie.

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* *American Journal of Science*, XX. 157.

† Medical Topographical Report of Tompkins County, in the *Transactions of the New-York State Medical Society*, III. 25.

‡ Medical Topography of the County of Tioga, in the *Transactions of the New-York State Medical Society*, III. 151.

Origin of the Sulphureous Springs.

From the descriptions which have now been given of our principal sulphureous springs, it appears they are almost coextensive with the limits of the State. There are, indeed, few counties in which they have not already been found; and, as a necessary consequence, their geological positions must be very various. On the Hudson river, they usually rise from the black glazed slate, or the soil which covers it. Proceeding westward from Albany, we have the Sharon springs issuing from the pyritous slates lying under the Helderberg limestone series. In Otsego and Herkimer counties, they rise from the drab limestone, and, it is believed, also from the calciferous sandrock. The celebrated springs of Chittenango emerge from the calciferous slate of Eaton; while in Onondaga county, they appear to have their origin in what are called the saliferous rocks. Again, the Avon springs rise from the hydraulic limestone; while those of a similar kind in Erie and Chautauque, issue from the pyritiferous shale. Thus it would seem that there are few rocks in the State, from which these springs do not emerge.

Although it is not easy to calculate the amount of sulphuretted hydrogen gas which is evolved by the springs in question, a reference to the notices which have been presented will be sufficient to prove that it must be enormous. The springs to which I would particularly direct attention, as illustrating the correctness of this statement, are those of Madison, Onondaga, Ontario, Livingston, Monroe and Niagara.

It may also be remarked, as a peculiarity of these springs, that a great uniformity prevails in regard to their chemical composition. The sulphuretted hydrogen is, in most cases, in simple solution in the water; although it is occasionally found, as has already been stated, in combination with some basis, forming a hydrosulphuret or hydrothionate. Sometimes, also, the quantity of gas evolved is so large, that when fired, it continues to burn for a considerable length of time. From this it may be inferred that a current of gas passes through the water, independently of the amount with which the water is impregnated.

In addition to the sulphuretted hydrogen, carbonic acid gas, in small quantities, has been found in most of the New-York sulphur springs which have been examined.

The solid matters which exist in these springs are also quite similar in their nature, whether occurring in rocks of the same, or of different kinds. Carbonate and sulphate of lime have been found in all these waters that have been subjected to analysis; while in some, sulphates of magnesia and soda have been detected. Chloride of sodium also occurs in many of them, and especially in those which rise in the vicinity of the brine springs. But the essential fixed ingredients seem to be one, two or more sulphates, which have undoubtedly been formed by the union of the bases with the sulphuric acid resulting from the decomposition of the sulphuretted hydrogen.

Another general fact in regard to these sulphuretted springs deserves to be here stated. It is, that so far as their temperature has been observed, it is always a little higher than the mean temperature of the locality in which they are found. Thus the temperature of the

Chittenango springs is 49° F., while the mean temperature of the village of that name is not far from 47.50°; the Onondaga springs have a temperature of 50°, while the mean temperature of Syracuse is about 47.90°; Longmuir's spring at Rochester has a temperature of 52°, while the mean temperature of that city is not above 49.37°; and there is about the same difference between the temperature of the Avon springs, and that of the village at which they are found. This remark will, I think, apply to most, if not all these springs; and it is of some importance, as it places them under the general head of Thermal Springs.

After these general statements, we shall probably have the means of testing the correctness of the theories which have been proposed to account for the formation of sulphureous springs.

Springs of this character have, perhaps, been most generally supposed to have their origin in the decomposition of iron pyrites. The following observations occur in the valuable work on Mineral and Thermal Springs, by Dr. Gairdner: "Iron pyrites," says he, "although incapable of giving rise to such general effects as were once supposed to be derived from it as a cause, may very well be the source of the sulphuric acid, sulphuretted hydrogen and sulphate of iron, of cold sulphureous and aluminous chalybeate waters. These generally emerge from strata in which this mineral is very abundantly disseminated, such as the coal formations, secondary and alluvial clays. The lias clay, for instance, in England, contains much iron pyrites, and is the chief seat of the sulphureous waters of this country, and of those which abound in large quantities of the earthy sulphates; and the strongest aluminous chalybeates generally percolate through beds of clay iron-stone, containing nodules of, or cemented together by, iron pyrites. Many of the compact fetid limestones, which are the matrix of sulphureous springs, disengage a strong odour of sulphuretted hydrogen when dissolved in an acid, and there floats on the surface of the solution a black bituminous matter."

In another part of the same work, the author observes: "Those (springs) which contain a considerable quantity of sulphuretted hydrogen gas, are very generally in the neighbourhood of beds of fossil combustible matter, more or less impregnated with bitumen and iron pyrites. Thus all the cold sulphureous waters of England either flow directly from, or are not far removed from, the great mass of the coal formation; and those in the north of Germany are similarly related to the brown coal deposits of the tertiary and newest secondary formations."*

It need not be repeated, that the account here given of the geological relations of the sulphureous springs of England and Germany is by no means applicable to those of the State of New-York. This, however, is not the only difficulty which attends the adoption of the proposed theory. It is well known, that for the decomposition of iron pyrites, the combined agency of air and moisture, continued for some time, is necessary. But the presence of these agents cannot be easily accounted for, without the introduction of other conditions, which appear to me to be inconsistent with the proposed explanation. Again, the constancy in the character of these springs, both as it respects their solid and gaseous constituents, which has been maintained in some instances for hundreds of years, and the comparatively small accumulations of

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* *Essay on the Natural History, Origin, Composition, and Medicinal Effects of Mineral and Thermal Springs.* By Meredith Gairdner, M. D.

iron pyrites which exist in any one portion of these rocks, would certainly lead to the conclusion that the source of these impregnations is much deeper than that which is here assigned to them.

But another strong objection to this theory of the origin of sulphureous springs is, that they very rarely contain sulphate of iron among their saline constituents. Now it is well known that the very agencies which would cause the evolution of sulphuretted hydrogen from iron pyrites, would also give rise to the formation of sulphate of iron. This being a soluble salt, we cannot understand why, if these waters are due to the decomposition of iron pyrites, they should not in every case contain the very substance which is at least one of the results of this decomposition.

Such are the objections to this view of the origin of these springs, even in those cases most favourable to its adoption; viz. where the springs emerge from strata which usually contain iron pyrites. But they are greatly increased in force, when the theory is proposed to be applied to those districts which are not thus characterized. We then have the additional difficulties presented, viz. the emergence of these springs from the oldest as well as the more recent rocks, as is exhibited in the State of New-York, and the vast amount of sulphuretted hydrogen which they evolve; an amount, which I think few would presume to refer to such an agency as that of the decomposition of iron pyrites, which seldom exists in any abundance in the older class of rocks.

We cannot, therefore, I think, without great violence, refer these springs to a local origin, which is insufficient to explain their widely extended occurrence, while a more general explanation will be equally applicable to all the facts which have been observed.

There are two general theories in regard to the origin of mineral springs. In both of them a general focus of action is recognized, which not only gives rise to what are usually considered as volcanic phenomena, but to mineral springs of whatever character, whether thermal or not. In one case, however, these phenomena are supposed to result from the mechanical action of the solidified crust of the earth upon a fluid nucleus, the state of fluidity being the result and the evidence of intense heat. In the other theory, they are ascribed to chemical processes carried on within the earth; these processes, however, being the same in their character as those which give rise to volcanic eruptions. In other words, they are the direct products of the great volcanic focus existing in the interior of the globe; and that volcanic action, of which they form one of the manifestations, is to be ascribed to a chemical agency.*

In the case of sulphureous springs, the substances necessary to their composition are water, sulphur, the alkaline and earthy bases, together with minute portions of carbonic acid and oxide of iron; the two last of which, however, may be independent of the general agency. All these bodies are known to be the products of active volcanoes — a circumstance of great importance in the discussion of this subject. This theory also receives confirmation from all the other facts which have been stated in regard to these springs, viz:

* On these general views, I would refer to a valuable paper, "On the Probable Origin of Mineral Springs," by C. E. Stifft, formerly Mining Engineer to the Duke of Nassau. *Edinburgh New Philosophical Journal*, XII. 290. — And also to an article "On the Mineral Springs of Iceland," by C. Krug Von Nidda; republished in the same work, Vol. XXII. 90.

1. Their general distribution.

2. Their emergence from various rock formations, without regard to their relative age or composition.

3. The vast quantity of this sulphuretted water, and of the gas evolved.

4. The uniformity and permanency of their composition and temperature.

5. The fact that almost all these springs have a temperature somewhat above that of the locality in which they exist, and that they may hence be fairly ranked in the class of thermal springs.

It is believed that the above facts cannot be satisfactorily explained without calling in the aid of some powerful, deep-seated and widely extended agency. A modification or extension of the chemical theory of volcanic action first proposed by Davy, and afterwards adopted and strenuously advocated by Prof. Daubeny, will, in my opinion, fulfil the conditions which a complete explanation requires. It is well known that this theory is founded upon the assumption that there exist in the interior of the earth vast quantities of the metallic bases of the alkalies and alkaline earths; that to these bases water is admitted, and, by its decomposition, a necessary consequence of such an admission, (at least in the case of many of these bases,) intense heat is produced, accompanied with vivid inflammation and the violent ejection of the various products thus formed. If we extend this admission to the existence of sulphur, or of the sulphurets of these metals, the presence and the action of water will give all the conditions which we require. In this way, we can readily account for the gaseous and solid matters which sulphur springs contain; for the wide extent of country over which they occur, and the other circumstances which characterize them; and also for what no other theory seems so well to explain, viz. the separate evolution of the gas through the water, the existence of the sulphates of lime, soda, etc., and the almost entire absence of sulphate of iron.

In conclusion, I will only add, that although it becomes us to speak with caution in regard to views of this kind, it is not easy to resist the conviction that the occurrence of our sulphureous springs, at least, must be ascribed to some general cause; and that like volcanoes, they are the outward exhibitions of the great volcanic focus, whether that is brought into operation by mechanical or chemical agencies.

PETRIFYING SPRINGS.

The history of petrifying springs affords a fine illustration of the intimate relations which exist between the researches of the chemist and geologist; for whatever difference of opinion may prevail concerning the true theory of the petrifying process which in many situations is daily going on, there is no doubt of the general fact that chemical agencies are largely concerned in it.

The explanation ordinarily given of the formation of travertin or calcareous tufa, stalactites, etc., is sufficiently simple, and may be easily comprehended. The water in certain springs holds in solution considerable quantities of carbonate and sulphate of lime, and occasionally of silica, which are deposited when the water comes into contact with the air. This process

is well exemplified in the formation of those small stalactites which are often found attached to the arches of aqueducts on our canals. The water contained in these aqueducts percolates through the limestone of which they are constructed, and thus becomes charged with carbonate of lime, which it again deposits when exposed to the air.* Many localities occur in this State, where extensive calcareous incrustations are formed in a similar manner. There is a very interesting exhibition of this kind near Camillus in Onondaga county, where, below the marly clay and beds of gypsum, these calcareous incrustations are found, which are both fibrous and crystallized; sometimes existing in regular strata; and at others, forming the walls of cavities of various figures and dimensions.

Simple as the explanation of these phenomena may seem, when it is known that water in its natural state always contains air and carbonic acid, which enable it to hold in solution a small quantity of carbonate of lime, it is not so easy to comprehend all the circumstances which attend the process of petrifaction, or the conversion of vegetable into stony matters; for it is to this only that our attention will at present be directed. That the most delicate parts of vegetables should be replaced by carbonate of lime, or silica, without any alteration of their form, is certainly one of the most curious operations going on in the laboratory of nature.

As might be inferred from what has already been said, these petrifying springs are most common in limestone regions. They therefore abound in the western parts of the State, although they are by no means confined to them.

Calcareous tufa is deposited from the water of springs near Whitehall in Washington County, and it is also to be met with in the Counties of Franklin and St. Lawrence; as, for example, near the Chateaugay Corners, and also about four miles from the village of Gouverneur.

In Schoharie County, tufa is found in great abundance on the sides of the mountains, from five to fifteen feet in depth, containing fine impressions of leaves, and covering grasses and mosses with incrustations so delicate as to preserve distinctly every fibre. And here it is to be remarked, that old deposits are covered with vegetable loam, on which shrubs and trees are growing.†

A very remarkable deposit of a similar kind is found near the head of the Otsquaga creek, in Herkimer County. It proceeds from the slate rocks, which are either the upper layers of greywacke or the calciferous slate. The calcareous tufa which proceeds from these rocks, contains the impressions of numerous plants of the same species which are now growing in the vicinity. There is a single mass on the bank of the creek, about three hundred feet long and fifty feet wide, and from ten to forty feet thick. It is very irregular in its form, and near the north end it is cavernous. Several rude apartments may be entered, which present curvi-

* The stalactites pendant on the arches of the aqueducts of our canals, have been called nitrate of lime; but all those which I have examined are pure carbonate of lime.

† See a valuable paper on the Geology and Mineralogy of Schoharie County, by John Gebhard, Esq. *American Journal of Science*, XXVIII. 172.

linear sides and irregular conical columns. At the southwestern termination of this extensive deposit, about a mile south of the cavern, there are the tufa petrifactions of six logs, which stand obliquely against a side-hill. They are still very perfect, (not having been often visited,) retaining the forms of the shelly scales of the bark, the knots, etc.*

Probably the most noted of the springs which are now under consideration, are those found in the vicinity of Chittenango, in Madison County. At the base of a hill, the rocky strata of which contain a large proportion of carbonate of lime, calcareous deposits and incrustations of various kinds are to be found. These have been formed, and are probably daily in the act of formation, by the agency of the waters which continually percolate through this hill of porous limestone. From this locality, specimens may be obtained of leaves, moss, wood, etc., in all states, from that of the proper vegetable, to that of the hard calcareous substance in which scarcely a trace of vegetable matter can be detected.

Similar deposits and petrifactions are very frequent in the County of Onondaga. At the base of a hill near Syracuse, large masses of tufa are to be seen. More extensive deposits occur in the towns of Marcellus and Camillus; and here, trunks of trees, and aggregates of leaves and roots, converted into pure carbonate of lime, are not uncommon.

Calcareous tufa is also found in great abundance near the Genesee Falls at Rochester, in Monroe County; in Cayuga County; near Ithaca, in Tompkins County; also near the Falls of Niagara, and in various other places which it is scarcely necessary to particularize. At the Niagara and Genesee falls, large masses of moss are found incrusted with carbonate of lime, evidently caused by the carbonate of lime held in solution by the waters which are continually passing over them. These incrustations, therefore, are undoubtedly to be referred to causes now in operation.

There is a great petrifying spring, and vast beds of tufa, at Caledonia, in Livingston County. The whole neighbourhood of that village is one of the most interesting in the State, and even the fences exhibit rich collections of organic remains.†

The vicinity of Chittenango probably affords the best opportunity for studying the circumstances attending the conversion of vegetable matter into carbonate of lime; and for the purpose of arriving at some conclusions with regard to these, I subjected to analysis various portions of the tufa or petrified vegetable matter, together with some of the water which issued from a side-hill, and appeared to be the agent concerned in the petrifying process.

The petrified wood was found to consist almost entirely of carbonate of lime, with very minute and variable portions of silica, alumina, and oxide of iron. As I have before remarked, in some specimens not a trace of vegetable matter was discoverable, while in others its presence could be easily detected. It is evident, therefore, that while the structure of the plant remains entire, the vegetable matter, by the petrifying process, is, wholly or in a great measure, replaced by the carbonate of lime.

From the side-hill at the base of which these specimens of petrified vegetables occur, springs of water every where burst out. The superincumbent rock contains a large proportion of

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* *Canal Rocks*, page 128.

† *New-York Review for January*, 1839.

carbonate of lime, and the sulphate of lime is also found in beds enclosed within it. The composition of this water is what might be expected from the nature of the strata through which it passes. The water from one of these springs had a faint smell of sulphuretted hydrogen, and contained a little carbonic acid. In 1000 parts, I found

Solid matter, consisting of carbonate and sulphate of lime, and sulphate of magnesia,	1.94
Water,	998.06

It is a curious fact, that in this water the sulphate of lime is in the largest proportion, while no trace of it can be discovered in the tufa. If this be true of all these springs, the sulphate of lime must be converted into a carbonate at the moment of its deposition, or soon after that deposition has taken place.

It has been conjectured that the conversion of vegetable into mineral matter is intimately connected with the phenomena of slow putrefaction, and that these must be studied whenever we attempt to reason on the conversion of fossil bodies into stone.*

In many of the specimens found at Chittenango, the petrified leaves, apparently of the beech, are much thicker than those which have not undergone this change; and from the prominence of the midrib and nerves, I am induced to think that the change commenced with the decay of the fleshy part of the leaf, and was completed by that of the more solid or woody portions.

In my Second Annual Report, I offered some views in regard to the manner in which the process of petrifaction is conducted. These, however, have been controverted; and I am not at present prepared to offer others less objectionable.

I have thus completed my account of the Mineral Springs of this State. Numerous and important as they now are, it cannot be doubted that the catalogue will hereafter be greatly extended. Being fully sensible of the great interest of the subject, I have devoted to it as much time and labour as a due regard to the other parts of the work entrusted to me seemed to warrant.

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* *Lyell's Address to the Geological Society of London*, 1837.

CATALOGUE *of the Mineral Springs in the State of New-York,*

COUNTY.	Kind of Spring.	Particular locality.	Geological situation, and height above tide.
Albany,	Acidulous sal. chalyb.	Near Boyd's Brewery, Ferry-street, Albany	Slate 300 ft. below tide
	Carburetted hyd. gas.	Ditto ditto ditto	Ditto ditto ditto
	Sulphureous	Ditto ditto ditto	Ditto 100 ft. above tide
	Ditto	Wendell's Hollow, near the city	Ditto
	Ditto	Town of Coeymans, near the landing	
	Ditto	Town of Guilderland, near W. McKown's	
	Ditto	Town of Watervliet, near Gen. Van Rensselaer's	Slate
	Ditto	Town of Rensselaerville, 3 m. from Preston Hollow	Middle portion of the Catskill series
	Petrifying	Town of Watervliet, near Gen. Van Rensselaer's	Slate
Broome,	Sulphureous,	In Nanticoke, 14 m. from Binghamton	
	Ditto	Bellona	
	Brine	Town of Lisle, near Chenango Forks	
Cayuga,	Brine	Several near the village of Montezuma	Marly clay 380 ft. above tide
	Sulphureous	Town of Sennet, 2 m. north of Auburn	
	Ditto	Four miles west of Auburn, on the farm of Nelson Van Ness	Limestone 650 ft. above tide
	Ditto	Spring Mills, on the eastern shore of Cayuga lake	
	Chalybeate	Town of Sennett, 5 m. northwest of Auburn	
	Petrifying	Town of Sempronius	
Cattaraugus,	Brine	Several near Rutledge, but unimportant	
	Gas	At the Oil Spring in Freedom, and elsewhere	
	Sulphureous	Near Randolph, and several upon the Cattaraugus creek and the South Branch	The Cashaqua shales
Chautauque,	Inflammable gas	In and near the village of Fredonia	Bitum. slate 692 ft. above tide
	Ditto	In Lake Erie, near Van Buren harbour	Slate 565 ft. above tide
	Ditto	At Portland harbour	
	Ditto	Town of Sheridan, and in various other parts of the county	
	Sulphureous	A mile east of Van Buren harbour	Bitum. slate 565 ft. above tide
	Ditto	Near the village of Laona	Ditto sandstone, 806 ft. above tide
	Ditto	Several in and near Fredonia,	Ditto slate 692 ft. above tide
Chenango,	Sulphureous	Shee's Spa, in the town of McDonough	
	Ditto	Two miles from the village of Norwich	
	Ditto	Town of Pharsalia	
	Ditto	Several in the town of Pitcher	
Clinton,	Sulphureous	Town of Beekman	
Columbia,	Chalybeate	Town of New-Lebanon, near the brick yard	
	Ditto	Near the Alum rock, so called, north of Lebanon Springs	
	Sulphureous	A mile and a half north of Kinderhook	Near junction of grey & blue clay
	Ditto	A mile east of Miller's, near the line of Claverack and Ghent	
	Ditto	A quarter of a mile east of Mr. Livingston's, of Oak Hill	
	Ditto	McNaughton's farm, between Leb. Springs and the Shaker village	
	Ditto	City of Hudson	Slate 150 ft. above tide
	Thermal	New-Lebanon	Transition limestone, &c.
	Inflammable gas	New-Lebanon, one on road to Stephentown, another on McNaughton's farm	
Cortland,	Brine		
	Sulphureous	Town of Preble	
Delaware,	Brine	About 4 m. from the village of Delhi	1384 ft. above tide
	Ditto	Farm of Geo. Dana, 3½ m. from village of Colchester, (unimportant)	
	Chalybeate	Several unimportant ones, in various parts of the county	
Dutchess,	Inflammable gas	In the town of Northeast, from the bottom of a lake	
	Ditto	A quarter of a mile from Ameniaville, on the road to Poughkeepsie	
	Sulphureous	1¼ m. north-northwest of Ameniaville, on land of Mr. T. Ingraham	
Erie,	Sulphureous	On Grand island	570 ft. above tide
	Ditto	Several on the Indian land, 4 m. west of Buffalo	
Essex,	Saline	Near Crown Point	

hitherto known, with their composition as far as determined.

Temp'ture.	Kind of gas evolved.	Total amount of solid matters in a pint.	Nature of the principal saline ingredients.	Authority
51° to 52°	Carb. acid, 28 cub. in. in a pint	75 grains	Chloride of sodium, carbonates of soda, lime, magnesia and iron	L. C. Beck.
------	Carburetted hydrogen.			
------	Sulphuretted hydrogen.			
------	Ditto ditto			
------	Ditto ditto			
------	Ditto ditto			
------	Ditto ditto			
------	Sulph. hyd. in mod. quantities.			
------	Carb. acid, in minute quantity.			
------	Sulph. hyd. moderate quantity.			
------	Ditto ditto			
------	Carbonic acid		Chloride of sodium.	
50°	Carbonic acid	790.70 grains	Chloride of sodium, magnesium and calcium, carbonate and sulphate of lime	L. C. Beck.
------	Sulph. hyd.			
------	Ditto 1.5 cub. inches	19.2 grains	Sulphates of lime and magnesia, chlor. of sod. and magn.	J. R. Chilton.
------	Ditto			
------	Carbonic acid.			
------	Ditto			
------			Chloride of sodium.	
------	Carburetted hydrogen.			
------	Sulphuretted hydrogen.			
------	Carburetted hydrogen.			
------	Ditto ditto			
------	Ditto ditto			
------	Ditto ditto			
------	Sulphuretted hydrogen		} Sulphate of lime.	
------	Ditto ditto			
------	Ditto ditto			
------	Sulphuretted hydrogen.			
------	Ditto ditto			
------	Ditto ditto			
------	Ditto ditto			
------	Sulph. hyd. and carbonic acid.			
------			Carbonate of iron.	
------			Ditto ditto	
------	Sulphuretted hydrogen.			
------	Ditto ditto			
------	Ditto ditto			
------	Ditto ditto			
73°	Nitrogen and atmospheric air	1.25 grains	Chlorides of sodium and calcium, sulph. and carb. of lime	Meade.
------	Carburetted hydrogen?			
------	Carbonic acid?		Chloride of sodium, &c.	
------	Sulphuretted hydrogen.			
------	Carbonic acid?		Ditto ditto	
------			Ditto ditto	
------	Carburetted hydrogen.			
------	Ditto ditto ?			
------	Sulphuretted hydrogen.			
------	Sulphuretted hydrogen.			
------	Ditto ditto			C. U. Shepard.
------		[saline matter 1000 parts contain 18.78	Sulphates of magnesia and lime.	

TABLE

COUNTY.	Kind of Spring.	Particular Locality.	Geological situation, and height above tide.
Franklin,	Nitrogen	Half a mile east of Chateaugay corners	
	Petrifying	Ditto ditto	
Genesee,	Sour springs	Near North Byron and in Bergen	
	Sulphureous	Ditto	
	Brine	In the town of Elba, 8 miles northwest of Batavia	
	Ditto	Town of Elba, on the land of John G. Satterlee	Same rock as that at Salina
Greene,	Petrifying	Many of the streams deposit extensive beds of calcareous tufa	
	Sulphureous	Near the Katerskill, 2 miles west of Catskill, on the farm of Henry Palmer	
	Ditto	A mile from the preceding on the other side of the creek, on farm of P. Acler	
	Ditto	Three-fourths m. west of Greenville, on the farm of Francis Hickok	
	Ditto	4 m. west of Athens, in a valley at the base of the Helderberg water lime group	
Herkimer,	Petrifying	On the Otsquago creek, in the town of Stark	
	Ditto	Ten miles south of Fort-Plain	
Lewis,	Sulphureous	Near Martinsburgh, and elsewhere in the county	Transit'n. limest. 800 ft. above tide
Livingston,	Petrifying	Caledonia.	
	Brine	Town of York, Near Hall's saw-mill	
	Sulphureous	At Caledonia village, a large spring slightly impregnated with gas	
	Ditto	Several near West Avon,	Hydraulic limestone
Madison,	Sulphureous	In the valley of the Chittenango creek, a mile south of the village of the same name, (Yates' spring)	Calciferous slate, 440 ft. above tide
	Ditto	In same valley, two miles south of Chittenango, (White Sulphur spring)	Ditto 450 ft. above tide
	Petrifying	Several issuing from side hill in immediate vicinity of Chittenango	Ditto
	Brine	Town of Lenox, near the Erie canal	425 ft. above tide
Monroe,	Ditto	In the town of Penfield, within a mile of Lake Ontario	Red sandstone
	Ditto	On the Irondequoit bay, from two to three miles from Lake Ontario	Ditto
	Ditto	In the town of Greece, 9 m. northwest from Rochester	
	Inflammable gas	Near the mouth of Genesee river	
	Sulphureous	Longmuir's, in the city of Rochester	Calciferous slate, 506 ft. above tide
	Ditto	At the village of Ogden, at the town of the same name, half a mile south of Spencer's basin	Red sandstone
	Ditto	Several in the towns of Gates, Mendon and Pittsford	Limestone
	Ditto	Caledonia spring, in the town of Wheatland, forming a large stream slightly impregnated with gas	
	Sulphureous	Monroe springs, 5 m. from Rochester, on the road to Pittsford	
	Ditto	In Ogden, on the land of Timothy Colby.	
	Inflammable gas	In Riga	Dark green gypseous marl
	Brine	Three, on the banks of Salmon creek in Clarkson, 2 m. north of Ladd's corners	Sandstone or indurated marl.
	Ditto	6 m. north of the preceding, on the land of Mr. Baxter	In limestone above shale.
New-York,	Saline	Cliff-street, New-York	
Niagara,	Sulphureous	At Lockport	
	Ditto	On the Tonawanda creek, 2 m. from the village.	
	Chalybeate	2 m. north of Lewiston, on farm of Capt. Leonard, several others in the vicinity.	
	Ditto	2 m. east of Lewiston	In the shale.
	Brine	Several along the course of Eighteen-mile creek, between Lockport and Lake Ontario	Limestone
	Ditto	3 miles from Lockport, from which salt was formerly made; also several unimportant ones along Golden Hill creek and Johnson's creek.	Ditto
	Inflammable gas	At Gasport, in the town of Royalton, 6½ miles east of Lockport	550 ft. above tide
	Petrifying	At Catlin's cave, half a mile below the falls. Calcareous tufa is found every where under the falls	Limestone
	Sulphureous	About a mile above the falls	Ditto 570 ft. above tide
	Ditto	On the bank of the Niagara, about two miles below the falls	Ditto
	Ditto	In the northern part of the town of Pendleton, near the canal	Ditto 565 ft. above tide

—(CONTINUED.)

Temp'ture	Kind of gas evolved.	Total amount of solid matters in a pint.	Nature of the principal saline ingredients.	Authority.
.....	Nitrogen	.....	.....	Emmons.
.....	Carbonic acid	.....	Carbonate of lime.	
.....	.....	.....	Sulphuric acid with lime, alumine and oxide of iron, ...	L. C. Beck.
.....	Sulphuretted hydrogen.			
.....	.....	.....	Chloride of sodium, &c.	
.....	.....	.....	Ditto	
.....	.....	.....	Carbonate of lime.	
.....	Sulphuretted hydrogen.			
.....	Ditto ditto			
.....	Ditto ditto			
.....	Ditto ditto			
.....	.....	.....	Ditto ditto	
.....	Sulphuretted hydrogen.			
.....	Ditto ditto			
.....	.....	.....	Chloride of sodium, &c.	
.....	Sulph. hyd.			
51°	Ditto and carbonic acid	17.08 grains.....	Sulphates of lime, magnesia and soda, chloride of sodium and carbonate of lime	Prof. Hadley.
49°	Ditto ditto	15.43 grains.....	Sulph. of lime and magn. carb. of lime and chloride of sod.	L. C. Beck.
49°	Ditto ditto	12.66 grains.....	Ditto ditto ditto ditto	L. C. Beck.
.....	Ditto ditto	.....	Sulphate and carbonate of lime	L. C. Beck.
.....	.....	.....	Chloride of sodium, &c.	
.....	.....	.....	Ditto ditto	
.....	.....	.....	Ditto ditto	
.....	.....	.....	Ditto ditto	
52°	Sulphuretted hydrogen.....	14.99 grains.....	Sulph. of lime and soda, chloride of sod. and carb. of lime.	L. C. Beck.
.....	Ditto ditto			
.....	Ditto ditto			
.....	Ditto ditto			
.....				
.....	Carburetted hydrogen.			
.....	Carb. acid and atmospheric air.	18.78 grains.....	Carbonate of lime and magnesia, sulphate of soda and magnesia, chloride of sodium	G. Chilton.
.....	Sulphuretted hydrogen.			
.....	.....	.....	Chloride of sodium, &c.	
.....	.....	.....	Ditto	
.....	Carburetted hydrogen.			
.....	.....	.....	Carbonate of lime.	
.....	Sulphuretted hydrogen..			
.....	Ditto ditto			
.....	Ditto ditto			

TABLE

COUNTY.	Kind of Spring.	Particular Locality.	Geological situation, and height above tide.
Oneida,	Brine	Near Vernon centre	
	Ditto	Ten miles west of Vernon village	
	Inflammable gas	A mile west of Vernon village, 17 m. west of Utica	
	Ditto	About half a mile northeast of the village of Hampton	Black shale
	Sulphureous	In the village of Augusta, 18 m. southwest of Utica	
	Ditto	Near the village of Paris, in the town of the same name	
	Ditto	Half a mile southwest from the village of Verona, 14 m. nearly west of Utica	
	Ditto	In the town of Paris, 9½ m. south of Utica	
	Saline	About half a m. northeast of the village of Hampton, town of Westmoreland, called "Halleck spring"	
Onondaga,	Brine	At Syracuse, Salina, Geddes and Liverpool	Marly clay ..... 390 ft. above tide
	Ditto	Two miles south of Syracuse; about 25 or 30 feet above the level of the Onondaga lake at Salina	
	Sulphureous	Between the branches of Limestone creek, near the village of Manlius	
	Ditto	In the town of De Witt, 3 m. northeast of Syracuse, known by the name of the "Messina spring"	Limestone
	Ditto	On the ground of Mr. E. F. Wallace, near the village of Syracuse	390 ft. above tide
	Ditto	Near the State well at Salina	
	Ditto	Lake Sodom, 2 m. east of Manlius centre	
	Saline	About a mile west of the village of Canastota	420 ft. above tide
	Chalybeate	At Foote's settlement	
	Ditto	In the town of Van Buren	
	Petrifying	On the banks of the Otisco outlet, in the town of Marcellus	
	Ditto	Near Syracuse, Onondaga, Manlius, Camillus, &c. where calcareous tufa is very abundant	
Ontario,	Inflammable gas	Bristol Hollow, town of Bristol, 9 m. WSW of Canandaigua	
	Ditto	On both sides of Canandaigua lake, within 3 m. of the village	
	Ditto	In East Bloomfield, and in the town of Richmond	
	Sulphureous	Several in the town of Phelps, about 11 m. NW of Geneva, known by the name of the "Clifton springs"	
	Ditto	On the banks of the outlet of Canandaigua lake	
Orange,	Ditto	About 2½ m. from the village of Newburgh, on the farm of Dr. M. Higby	About 150 ft. above tide
	Ditto	On the farm of G. Clinton, Jr. Esq. in the town of New-Windsor	
	Chalybeate	On the top of Shawangunk mountain, in the town of Minisink	
Orleans,	Brine	At Fairhaven, in the town of Gaines, small	
	Ditto	In town of Kendall, lot 137, from which salt was formerly made	
	Ditto	Near Scofield's mills, in town of Yates; salt formerly made from it	
	Sulphureous	Two at Holley Village; weak	
	Brine	In the town of Murray, near Sandy creek	
	Ditto	In the town of Ridgeway, between the Erie canal and Ridge road	
	Ditto	Near Holley village, on the canal, three, salt formerly made from them	500 ft. above tide
Oswego,	Ditto	In the towns of Constantia, Richland and Sterling	
	Ditto	In the town of Hannibal, a mile northeast of Kinney's corners, called "Burr's Salt Works"	
	Ditto	In various parts of the town of Hastings; one 4 m. west from Central Square; another 2 m. west of this, and a third at Central Square	
	Ditto	In the town of Palermo, on the land of George G. Grizzle	
Otsego,	Sulphureous	Several north of Cherry-Valley, below the falls	From the drab limestone
	Brine	At Salt Springville, partly in this and partly in Montgomery county	
	Sulphureous	In the town of Richfield	
	Ditto	Near Cherry-Valley	1,335 ft. above tide
Rensselaer,	Ditto	Near the village of Bath, opposite to Albany	Slate ..... 20 to 30 ft. above tide
	Ditto	Near Greenbush, opposite to Albany, and near the seat of Mrs. Genet three miles south of Albany	Slate
	Ditto	At the north end of the city of Troy, and in various other parts of the county	20 to 30 ft. above tide
	Nitrogen	In the southeast corner of the town of Hoosick, six miles southeast of the village of Bennington, Vt.	
	Chalybeate	One mile from Sandlake; issues from gravel.	

—(CONTINUED.)

Temp'ture	Kind of gas evolved.	Total amount of solid matters in a pint.	Nature of the principal saline ingredients.	Authority.
----	----	----	Chloride of sodium, &c.	
----	----	----	Ditto ditto	
----	Carburetted hydrogen.			
----	Ditto ditto	----	----	Vanuxem.
----	Sulphuretted hydrogen.			
----	Ditto ditto			
----	Ditto ditto	107.25 grains	Chlorides of sod. calcium and magn. and carb. of soda	Dr. J. Noyes.
----	Ditto ditto			
----	Carb. hyd. and carbonic acid	100.00 grains	Ditto ditto and sulph. of lime	Dr. J. Noyes.
50° to 51°	Carbonic acid	From 1115 to 1250 grs.	Chlorides of sod. calcium and magn. sulph. and carb. of [lime	L. C. Beck.
----	Ditto	----	Chlorides of sodium, &c.	
----	Sulph. hyd.			
50°	Ditto	13.09 grains	Carb. and sulph. of lime, sulph of magn. & chlor. of cal.	L. C. Beck.
50°	Ditto and carbonic acid	133.64 grains	Chlor. of sod. calc. and magn. carb. and sulph. of lime	L. C. Beck.
50°	Ditto ditto	186.41 grains	Chloride of sodium, &c. &c.	L. C. Beck.
----	Ditto			
----	----	----	Chlorides of sodium and magnesium, and sulphate of lime	C. A. Spencer.
----	Carbonic acid.			
----	Carbonic acid	----	Carbonate of lime.	
----	Carburetted hydrogen.			
----	Ditto ditto			
----	Ditto ditto			
----	Sulphuretted hydrogen.			
----	Ditto ditto			
----	Ditto ditto			
----	Ditto ditto			
----	Carbonic acid?			
----	----	----	Chloride of sodium.	
----	----	----	Ditto ditto	
----	----	----	Ditto ditto	
----	Sulphuretted hydrogen.			
----	Carbonic acid	----	Ditto ditto	
----	Ditto	----	Ditto ditto	
----	Ditto	----	Ditto ditto	
----	Ditto	----	Ditto ditto	
----	Ditto	----	Ditto ditto	
----	Ditto	----	Ditto ditto	
----	----	[1 oz. of salt. A pint of water contains		
----	----	----	Deposit tufa and sulphur.	
----	Carbonic acid	From 250 to 290 grains	Chloride of sodium.	
----	Sulphuretted hydrogen.			
----	Ditto ditto			
----	Ditto ditto			
----	Ditto ditto			
----	Ditto ditto			
----	Nitrogen	----	Chlorides of sodium and calcium.	

TABLE

COUNTY.	Kind of Spring.	Particular Locality.	Geological situation, and height above tide.
Richmond,	Chalybeate.		
St. Lawrence,	Sulphureous	On the banks of the River Racket, about a mile from the village of Massena. Several others occur on the same stream	
	Petrifying	Four miles northwest of the village of Gouverneur	
Saratoga,	Acid. saline chalyb.	Congress Spring, in the village of Saratoga Springs	
	Ditto ditto	Columbian Spring, 15 or or 20 rods southwest from the Congress	
	Ditto ditto	Washington Spring, 50 rods southwest from the preceding	
	Ditto ditto	Hamilton Spring, 50 rods northeast from the Congress	
	Ditto ditto	Flat Rock Spring, about 100 rods northeast of the Hamilton Spring	
	Ditto ditto	High Rock Spring, about 100 rods north of the preceding	
	Ditto ditto	President Spring, about 30 rods northeast of the High Rock	
	Ditto ditto	Red Spring, from 60 to 70 rods northeast of the President Spring	
	Ditto ditto	Barrel Spring, near the High Rock; Walton Spring, in rear of Columbian Hotel; Monroe Spring, 15 or 20 rods north of Flat Rock	
	Ditto ditto	Ten Springs, about a mile east of the High Rock	
	Ditto ditto	Ellis Spring, about 2 m. in a SW direction from Congress Spring	
	Ditto ditto	Several in the town of Saratoga, about 10 miles southeast of the Congress Spring, called the Quaker Springs	
	Ditto ditto	Sans Souci Spring, in rear of Sans Souci, village of Ballston Spa	Slate
	Ditto ditto	United States Spring, a short distance from the preceding	Ditto
	Ditto ditto	Public Well, near the centre of the village of Ballston Spa	Ditto
	Ditto ditto	Washington Spring, in the street, a few rods south of the former	Ditto
	Acidulous chalybeate	Park Spring, in rear of the Village Hotel, Ballston Spa	Ditto
	Ditto ditto	Fulton Spring, Ballston Spa, 19 feet from the United States Spring	Ditto
	Sulphureous	Franklin Spring, 12 feet from the United States Spring	
	Ditto	On the eastern bank of Saratoga lake, about a mile S. of Snake Hill	
	Ditto	Two or three miles west of Saratoga Springs	
	Petrifying	Calcareous tufa is abundant in the vicinity of several of the springs in this county.	
Schoharie,	Sulphureous	Sharon. Several strongly impregnated	
	Chalybeate	3 m. from Oak Hill, on the road to Freehold, on farm of W. Barlow.	
	Sulphureous	Several near the village of Leesville, in the town of Sharon	
	Chalybeate	Near the preceding	
	Petrifying	Calcareous tufa is found in abundance in various parts of the county.	
Seneca,	Sulphureous?	In the village of Waterloo.	
	Nitrogen	Canoga	
Steuben,	Brine	At La Grange, on the land of Mr. Davis	Green shale
	Sulphureous	Near Campbelltown, a village in the NW part of town of Campbell.	
	Ditto	At the post-office in the town of Jasper	
	Ditto	In the town of Urbana	
Tioga,	Ditto	In the town of Tioga	
	Ditto	In SW part of the town of Barton, on the east bank of the Chemung	
Ulster,	Sulphureous	Town of New-Paltz, one mile west of Springtown, nearly opposite Buntico point	
Tompkins,	Ditto	In the town of Dryden, 10 miles east of Ithaca	
	Ditto	On Six Mile creek, a mile or two southeast of Ithaca	417 ft. above tide
	Petrifying	Near the village of Ithaca	
Wayne,	Brine	In the town of Galen	About 450 ft. above tide
	Ditto	In the village of Clyde	Sandstone,
	Ditto	Near the head of Little Sodus bay	Ditto
	Sulphureous	In Brown's mill pond, one and a half miles south of Newark	Gypseous rocks
	Ditto	On Salmon creek, near the forge in Sodus	Red sandstone
	Ditto	One or two at and near Palmyra	Gypseous rocks
	Ditto	At Jenkins' hill, in the village of Clyde	Ditto
	Ditto	Half a mile northeast of Marion Centre	Bituminous limestone
	Brine	Two miles from Lockville, near the canal	Gypseous rocks
Washington,	Acid. saline chalyb.	At Reed's, in South Argyle	Mohawk limestone
	Petrifying	Springs in various parts of the county	
Westchester,	Sulphureous	Chappequa Spring, three and a half miles east of Sing-Sing	
Yates,	Inflammable gas	Federal Hollow, in the town of Middlesex, a mile from Rushville, and about 21 miles from Palmyra	

—(CONCLUDED.)

Temp'ture.	Kind of gas evolved.	Total amount of solid matters in a pint.	Nature of the principal saline ingredients.	Authority
.....	Sulphuretted hydrogen.			
.....	Carb. acid	.....	Carbonate of lime.	
50°	Ditto & at. air, 39.75 cu. in.	74.78 grains	Chlo. of sod. carb's of soda, magn. lime, iron ; iod. bromine	Dr. J. H. Steel
50°	Ditto ditto 34.75 do	50.91 grains	Ditto ditto ditto ditto	Ditto
50°	Ditto ditto 33.66 do	54.87 grains	Ditto ditto &c. iodine	Ditto
50°	Ditto ditto. 40.00 do	57.54 grains	Composition similar to the preceding	Ditto
48°	Ditto ditto 36.75 do	34.95 grains	Ditto ditto	Ditto
48°	Ditto ditto 38.62 do	43.21 grains	Ditto ditto	Ditto
.....	Carbonic acid	.....	Ditto ditto	
.....	Ditto	.....	Ditto ditto	
.....	Ditto	.....	Ditto ditto	
.....	Ditto	.....	Ditto ditto	
.....	Ditto	.....	Ditto ditto	
.....	Ditto	.....	Ditto ditto	
50°	Ditto	.....	Ditto ditto	
50°	Ditto and atmos. air..	60.82 grains	Chlo. of sod. carb. of lime, magn. and soda, sulph. of soda,	L. C. Beck.
50°	Ditto ditto ..	.....	Composition similar to the preceding.	
50°	Ditto ditto ..	.....	Ditto ditto [of oxide of iron	
50°	Ditto ditto ..	.....	Ditto ditto but contains a large proportion	
50°	Ditto ditto ..	.....	Ditto ditto ditto ditto	
.....	Sulphuretted hydrogen.			
.....	Ditto ditto			
.....	Ditto ditto			
.....				
.....	Sulphuretted hydrogen	.....	Carb. and sulph. lime, magnesia and iron.	
.....	Sulphuretted hydrogen			
.....	Carbonic acid			
.....	Nitrogen gas	Temp. 40°.		
.....	Carburetted hydrogen	.....	Chloride sodium, &c.	
.....	Sulphuretted hydrogen.			
.....	Ditto ditto			
.....	Ditto ditto			
.....	Ditto ditto			
.....	Ditto ditto			
.....	Sulph. hydrogen, copiously.			
.....	Sulphuretted hydrogen.			
.....	Ditto ditto			
.....	.....	.....	Carbonate of lime.	
.....	.....	[1,000 of brine.		
.....	Carbonic acid	84.24 parts of sal. mat. in	Chlorides of sod. cal. and magn., sulph. and carb. of lime..	G. Chilton.
.....	Carburetted hyd. and carb. acid			
.....	Carbonic acid	Requires 140 gallons for	Chloride of sodium, &c.	
.....	Sulphuretted hydrogen.	a bushel of salt		
.....	Ditto ditto			
.....	Ditto ditto			
.....	Ditto ditto			
.....	Ditto ditto			
.....	.....	.....	Chloride of sodium, &c.	
.....	Carbonic acid	.....	Similar to the Saratoga waters.	
.....	Ditto	.....	Carbonate of lime.	
.....	Sulphuretted hydrogen.			
.....	Carburetted hydrogen.			

PART II.

DESCRIPTIVE MINERALOGY.

DESCRIPTIVE MINERALOGY.

CLASS I.

GASEOUS MINERALS.

These substances are sometimes found in a free state; at others they are held in solution by water, under pressure, but are given out when the pressure is relieved. Some of them burn upon the application of a lighted taper; others do not.

ORDER I. COMBUSTIBLE GASES.

There are four of these combustible gases which have been found in nature, viz:

1. Hydrogen.
2. Carburetted Hydrogen.
3. Sulphuretted Hydrogen.
4. Phosphuretted Hydrogen.

HYDROGEN.

[From the Greek ὑδωρ, *water*, and γενναω, *I generate;* because it is a constituent of water.]

Hydrogen Gas. *Cleaveland.* — Hydrogen. *Shepard* and *Dana.* — Reines Hydrogen-Gas. *Mohs.* — Hydrogène. *Beudant.*

Description. Gaseous, colourless, inodorous, and transparent; absorbed by water in very small quantity. It is the lightest substance known, its specific gravity being 68.8, compared with air at 1000.0.

This gas burns with a feeble flame when in contact with the atmosphere, but it extinguishes burning bodies. When mixed with oxygen and fired with a lighted taper or with the electric spark, it explodes violently, and the result is the formation of water.

Uses. Hydrogen gas may be procured in large quantities by various processes. It was at one time used for filling balloons; but recently coal gas has been substituted for it, on account of its being cheaper and more convenient. The latter gas, however, being much heavier than pure hydrogen, the balloon must be very large.

LOCALITIES.

Hydrogen gas is evolved from various kinds of rocks, as limestone, the coal series, etc.; also from stagnant waters of various kinds. It is said in some cases to be found pure, but it is most generally mixed with carbon or sulphur. I am not aware of its occurrence in any quantity in a pure form in New-York; but it is not improbable that, among the abundant localities of carburetted and sulphuretted hydrogen, it may hereafter be found to exist. According to Beudant it is always mixed with the carburetted or sulphuretted hydrogen disengaged from *salzes* or from fissures in the earth, in their immediate vicinity.

CARBURETTED HYDROGEN.

Carburetted Hydrogen Gas. *Cleaveland.* — Carburetted Hydrogen. *Shepard.* — Empyreumatisches Hydrogen-Gas. *Mohs.* — Grizou. *Beudant.*

Description. Gaseous, colourless and transparent; soluble in very minute proportions in water. It has an empyreumatic odour. Its specific gravity is from 559 to 570, compared with atmospheric air as 1000.

This gas burns with a flame which is yellowish white or white, apparently according to the relative proportions of its ingredients. It extinguishes burning bodies, is fatal to respiration, and when mixed with atmospheric air or hydrogen gas and ignited, explodes violently.

Composition. The real composition of this gas, which is known in chemical works under the names of *Light Carburetted Hydrogen* or *Marsh Gas*, is carbon 74.87, and hydrogen 25.13; but its real atomic weight seems still to be a matter of uncertainty. It has usually been thought to be a compound of one atom of carbon and two atoms of hydrogen; but Kane thinks there is reason to suppose it to be two atoms of carbon and four of hydrogen. As it occurs in nature and under various circumstances, it is probably not constant in its composition. It may sometimes be mixed with variable proportions of these substances in their separate form. Its formula is either CH_2 or C_2H_4.

Uses. This gas, in the form in which it is sometimes evolved, may be employed for the purpose of illumination.

LOCALITIES.

In the preceding part of this work I have given a full account of the localities of this gas, under the head of Gas or Carburetted Hydrogen Springs (page 128). I will only add here that it issues from clefts in rocks of various kinds, and principally abounds in the western

part of the State. Although it often passes through water, it is but sparingly absorbed by it. Its origin, like that of many of the other gases which are evolved from the surface, is probably deep seated.

SULPHURETTED HYDROGEN.

Sulphuretted Hydrogen Gas. *Cleaveland.* — Sulphuretted Hydrogen. *Shepard.* — Schwefliges Hydrogen-Gas. *Mohs.* — Hydrogène Sulfuré. *Beudant.*

Description. Gaseous, colourless, transparent; absorbed by water. It has a very offensive taste and odour resembling that of rotten eggs, by which it can be distinguished from all other gases. It is heavier than atmospheric air, its specific gravity being 1177, and that of air 1000.

This gas is highly inflammable, and burns with a pale blue flame; but it extinguishes burning bodies, and cannot be safely breathed in any quantity. With oxygen gas it forms a mixture which detonates by the application of flame, or by the electric spark. It blackens the salts of lead, and many other metallic compounds.

Composition. Sulphur 94.18, hydrogen 5.82. It contains, therefore, one atom of each of the constituents. Its formala will be SH.

Uses. In addition to the medical virtues which are ascribed to this substance, it is an extremely useful reägent in the laboratory. It is employed in the gaseous form, in solution in water, and in combination with ammonia as a test for the metals.

LOCALITIES.

This gas is abundantly evolved in various parts of the State, and it forms what are called *Sulphureous*, *Sulphuretted* or *Hydrosulphuretted Springs*. Of these, a detailed notice, together with an examination of the theory of their origin, will be found in the first part of this work (page 141).

PHOSPHURETTED HYDROGEN.

Phosphoriges Hydrogen-Gas. *Mohs.*

Description. Gaseous, transparent, colourless; sparingly absorbed by water. It has an offensive smell resembling that of garlic. Its specific gravity is 1185, compared to air as 1000.

This gas does not support flame or respiration, but is characterized by inflaming spontaneously when mixed with air or with oxygen gas.

Composition. Phosphorus 91.29, hydrogen 8.71, or one atom of the former and three atoms of the latter. Its formula is PH_3.

This gas is sometimes given out by marshes, and is probably formed by the decomposition of animal and vegetable matters. As it is spontaneously inflammable, it has been known by the names *Ignis fatuus*, *Lantern Jack*, &c. It is sometimes mixed with carburetted hydrogen.

ORDER II. NON-COMBUSTIBLE GASES.

Under this order are included

1. Oxygen.
2. Nitrogen.
3. Carbonic acid.
4. Atmospheric air.

OXYGEN.

[From the Greek οξυς, *an acid*, and γενναω, *I generate;* it having been formerly supposed to be essential to acidity.]

Description. Gaseous, colourless, inodorous, tasteless, and transparent; sparingly dissolved by water. It is a powerful supporter of combustion, and is essential to respiration. Specific gravity 1102, water being 1000.

Burning bodies introduced into this gas burn with greatly increased brilliancy, and even some substances, which are not ordinarily thought to be combustible, when ignited, undergo rapid combustion in it; as iron wire, steel watch springs, etc.

This gas is largely evolved from vegetables. The carbonic acid which they absorb is decomposed, the carbon being appropriated to the vegetable and the oxygen given out. In some cases it is said to predominate in the air given out by springs. I have introduced it chiefly for the purpose of directing attention to the subject.

NITROGEN.

[So called from its being the basis of nitric acid and nitre.]

Nitrogen. *Shepard* and *Dana*. — Azote. *Beudant*.

Description. Gaseous, colourless, transparent, tasteless and inodorous; it is absorbed by water only in very small quantity. It is lighter than atmospheric air, its specific gravity being 976, compared to air as 1000. It does not support combustion nor animal life, and is indeed characterized by the absence of those properties which distinguish the other gases.

LOCALITIES.

This gas is given out in considerable abundance, and in a state of purity or nearly so, in the town of Hoosick in Rensselaer county, at Lebanon in Columbia county, Canoga in Seneca county, and at Chateaugay in Franklin county. These localities are particularly described under the head of Nitrogen Springs (page 133).

CARBONIC ACID.

Carbonic Acid. *Cleaveland* and *Shepard*. — Gasförmige Kohlen Saure. *Mohs*. — Acide Carbonique. *Beudant*.

DESCRIPTION. Gaseous, colourless, inodorous, and uninflammable; soluble in water, to which it communicates an agreeable subacid taste. Its specific gravity is 1521, compared with air as 1000. It possesses acid properties both when free and when in solution. When test paper is reddened by it, the original colour is restored upon the application of heat. It extinguishes all burning bodies, and when breathed in any quantity, is fatal to life.

COMPOSITION. Carbon 27.4, oxygen 72.6. Its formula is CO_2.

USES. In the form of solution in water, carbonic acid is largely consumed as a beverage under the name of *soda water*. It is also the basis of other effervescing drinks. The quantity of gas absorbed by water is much increased by pressure; and when this pressure is removed, the gas escapes with effervescence.

In consequence of the great expansibility of the solidified gas, it was at one time supposed that it would be a valuable moving power, but this idea is now abandoned.

LOCALITIES.

Carbonic acid is often found in the bottoms of wells, caverns, and other similar situations, in considerable quantities. In such cases its occurrence is supposed to be owing to certain decompositions of carbonate of lime which are effected below the crust of the earth, as the acid, though ever so frequently removed, is again produced. Its presence may be detected by introducing a lighted candle into the suspected air, when, if carbonic acid be present, the candle will be extinguished. This is a precaution which should always be used before descending into wells or unexplored caverns, especially in limestone countries. Many lives have been lost, through want of attention to this simple test of the presence of this gas. As its specific gravity is considerably greater than that of atmospheric air, it may be removed from wells by large buckets or tubs in the same manner as water. Pure slaked lime may also be used for the same purpose, as the carbonic acid readily combines with it and forms carbonate of lime.

Most of our wells and springs contain a small quantity of carbonic acid, and from many of our mineral springs it is abundantly evolved. The most remarkable in this respect are the springs of Saratoga and Ballston, where the quantity of this gas which is given out is sometimes so great as to resemble a volcanic eruption. I have been informed that some years since there was a discharge of this gas from the creek in the village of Ballston, which threw

the water several feet into the air; but the gas soon diminished in quantity, and can now be observed rising only in small bubbles through the bed of the stream (see page 137).

The carbonic acid which is given out by various mineral waters is sometimes in a free state, as is the case at Ballston and Saratoga, where large bubbles rise through the water at regular and short intervals; or it holds in solution various bases in the form of bicarbonates, which, as soon as a portion of the acid is evolved, are deposited as simple carbonates. Such phenomena are observed at the brine springs in Onondaga county and elsewhere, and at those which are called *petrifying springs*, of which there are many in Western New-York.

As I have already noticed this subject at length under the head of mineral springs, it will be unnecessary to add further particulars (see page 134).

ATMOSPHERIC AIR.

Atmospheric Air. *Shepard* and *Dana.* — Reines Atmosphär-Gas. *Mohs.*

Description. Gaseous, transparent, tasteless and inodorous; sparingly absorbed by water. When in large masses, it reflects a blue colour. Its specific gravity is taken as the standard for all gases and vapours, and is therefore 1000. It is about 780 times lighter than water at 40.5 Fahr., when water is at its greatest density, and is then also 10,600 times lighter than quicksilver. *Kane.*

Composition. The constituents of atmospheric air, are nearly as follows, viz: Nitrogen gas 75.88, oxygen gas 23.04, watery vapour 1.03, carbonic acid 0.05. These ingredients, however, are thought to be rather in the form of mixture than of true chemical combination. Their proportions are moreover liable to slight variations from general and local causes.

Atmospheric air is sometimes given out through the clefts of rocks, and is associated with the other gaseous minerals which are peculiar to certain springs. Thus Dr. Daubeny states that the gaseous matter evolved by the water of the Lebanon spring consists of about fifty parts of atmospheric air and fifty parts of nitrogen, in the hundred. Small quantities of air have also been detected in several of the Saratoga springs. In this case its origin is probably the same as that of the other gaseous contents. The air which is uniformly found in the water of fresh water springs may also, I think, be referred to some deep seated and general agency.

That atmospheric air does find its way into the interior of the earth, through the cracks and fissures with which its crust is every where intersected, the large cavities it so frequently envelopes, and perhaps through its porous and permeable structure, is an idea which seems to be sufficiently well sustained. If such is really the fact, it will not be difficult to account for the occurrence of atmospheric air, and occasionally of pure nitrogen, in the waters of certain springs. To account for the latter, we have only to suppose that certain processes, occasioning the abstraction of oxygen from common air, are going on in the interior of the earth.*

* See Dr. Daubeny's Report on Mineral and Thermal Waters. *Reports of the British Association for the Advancement of Science*, 1836.

CLASS II.

LIQUID MINERALS, NOT COMBUSTIBLE.

These substances are liquid at ordinary temperatures, and are not combustible. One of them is acid; the others do not possess that property.

ORDER I. LIQUID ACIDS.

There is only one substance in New-York belonging to this order, viz. Hydrous Sulphuric Acid.

HYDROUS SULPHURIC ACID.

Sulphuric Acid. *Cleaveland* and *Shepard.*— Tropfbare Schwefel-Säure. *Mohs.*— Liquid Sulphuric Acid. *Jameson.* — Acide Sulphurique Hydraté. *Beudant.*— Oil of Vitriol.

Description. In its pure form it is a heavy inodorous oily liquid, which is exceedingly corrosive. Even when largely diluted with water it has a very sour taste, and reddens litmus. Its specific gravity when concentrated is 1.847, water being 1.000. By the action of carbon aided by heat, it is converted into sulphurous acid. Its presence may always be detected by the white insoluble precipitate produced in a dilute solution of it by the addition of a few drops of the solution of nitrate or muriate of barytes. To distinguish the native sulphuric acid from sulphates with an excess of acid, recourse may be had to evaporation; in the former, little or no residuum is perceived.

Composition. In its concentrated form this acid contains sulphur 32.79, oxygen 48.88, water 18.83. Its formula is $SO_3 + HO$.

Uses. Sulphuric acid is known to be one of the most important substances now manufactured. There are very few arts in which it is not in some way or other employed. Indeed it has been remarked by Dumas, that the state of the arts in any country can be in a great measure determined by ascertaining the amount of this acid which is manufactured.

LOCALITIES.

The occurrence of this acid has heretofore been noticed almost exclusively in the vicinity of volcanoes, or in volcanic districts. A remarkable locality of it exists in the southwest corner of the town of Byron, in Genesee county. The acid is produced from a hillock elevated several feet above the surrounding plane. The hillock is covered with vegetable matter

which has been charred by the action of sulphuric acid, and which, though no water flows from it, is always quite damp. This vegetable matter has an intensely sour taste. About two miles east of the preceding there is a spring consisting of dilute sulphuric acid, which issues from the earth in considerable quantity. I examined with care the liquid acid, and the brownish vegetable matter subjected to its action. The former was found to be nearly pure sulphuric acid mixed with water; and the latter yielded, upon being boiled in water, a similar solution. The acid could not have been derived from an acid sulphate, as the bases were found only in very minute quantity. (See page 150.)

It is said that at the time when this county was first settled, a copious spring of an intensely sour water issued from the top of the mound; but that in digging about the spring for the purpose of making it deeper, the whole was lost, and since that time it has only appeared in the spring of the year. The rocks below are the gypseous marls, and nearly or quite the same as those which are found below the sour springs in the town of Bergen.* In the town just named, there are several springs which contain sulphuric acid. One of these, however, is much stronger than the rest. They rise from the grey marl and gypsum. It is worthy of remark that some of the wells in the immediate vicinity, and in the same formation, yield good water.

ORDER II. LIQUID MINERALS, NOT ACID.

This includes the two following, viz:

1. Atmospheric Water. 2. Sea Water.

ATMOSPHERIC WATER.

Atmospheric Water. *Shepard.* — Pure Atmospheric Water. *Jameson.* — Reines Atmosphär-Wasser. *Mohs.* — Eau. *Beudant.*

Description. Liquid at ordinary temperatures, transparent, tasteless and inodorous. Specific gravity 1.000, all solid and liquid bodies being referred to it as the standard. It is about 828 times heavier than atmospheric air.

At the temperature of 32° Fahr. water becomes solid, and it then sometimes appears in a variety of crystalline forms, usually having a hexagonal nucleus. When heated to 212° Fahr. it assumes the form of vapour or steam, and if this vapour be made to pass through a tube stuffed with iron wire and heated to redness, it is decomposed, the oxygen combining with the iron, and the hydrogen passing off in the form of gas.

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* Hall. *New-York Geological Reports*, 1840.

Composition. Oxygen 88.94, hydrogen 11.06 (*Berzelius*). But it almost always contains small portions of foreign matter. Its formula is HO.

The purest water that can be found as a natural product is rain, river, or spring water, or that obtained by melting freshly fallen snow. All these, however, contain portions of air, and sometimes minute quantities of saline matter. Snow water usually contains some organic matter, the exact nature of which has not been determined.

Most of the well water in various parts of this State contains small portions of carbonate, sulphate and muriate of lime. The presence of the two former is often rendered quite evident by the calcareous crust formed in culinary vessels, in which this water is constantly subjected to heat. The presence of muriate of lime may be detected by the addition of a few drops of nitrate of silver to one portion of the water, and of oxalate of lime to another. A white precipitate will in both cases be the result if this compound is present.

In the vicinity of the sea, and of the brine springs in the western part of New-York, small quantities of common salt are found in the water of wells. But it is a curious fact, that sometimes in the immediate vicinity of a highly charged mineral spring, there will be found water of a very great degree of purity. This can only be accounted for on the supposition that this latter has its origin in a different subterranean reservoir.

It has recently been proved by the experiments of Liebig and others, that atmospheric water usually contains ammonia. This alkali is known to be one of the products of the putrefaction of animal and vegetable matters. It is thus conveyed into the atmosphere, and being very soluble in water, is brought down again by rain and snow. Leibig supposes that it is from the decomposition of this substance that plants receive that portion of nitrogen which seems to be so essential to their growth.

SEA WATER.

Common Sea Water. *Jameson.*

Description. Liquid, having a bitter nauseous taste and disagreeable smell. Specific gravity varying from 1.026 to 1.035.

Composition. Sea water generally contains the following ingredients in 100 parts, viz: Chloride of sodium 2.50, chloride of magnesium 0.35, sulphate of magnesia 0.58, carbonate of lime and carbonate of magnesia 0.02, sulphate of lime 0.01, water 96.54, together with some traces of iodide and bromide of magnesium. *Kane.*

In 100 parts of water there are chloride of sodium 2.50, sulphate of magnesia 0.53, chloride of magnesium 0.35, carbonate of lime 0.02, sulphate of lime 0.01, besides $\frac{1}{200}$ of sulphate and muriate of potash. It contains also iodide of sodium and bromide of magnesium. *Ure.*

Water from the Frith of Forth. Chloride of sodium 2.20, sulphate of soda 0.33, chloride of magnesium 0.42, chloride of calcium 0.07. *Jameson.*

It appears, therefore, from the above analyses, that there is some variation in the nature as well as in the proportion of the ingredients of sea water. The total amount of saline matters is also different in different parts of the ocean. Thus the water of the Baltic sea is said to contain $\frac{1}{64}$ of its weight of salt (or 1.5 per cent.); that of the sea between England and France contains $\frac{1}{32}$ part (or 3.1 per cent.); and that on the coast of Spain, $\frac{1}{16}$ part (or 6.1 per cent.) *Ure*. Some inland seas, however, contain a still larger proportion of saline matter. The most remarkable of these is the Dead Sea, the water of which, according to Marcet, contains 25.10 per cent. of salts.

A knowledge of the relative proportion of common salt which sea water contains is of importance, as it is upon this that the question of the feasibility of establishing the manufacture of that valuable article must often depend. From the statements which have already been made in regard to the proportions of saline matter found in different seas, it may be inferred that the water within the boundaries of this State is not so strongly impregnated as to render this manufacture of much consequence, especially while the strongly charged brine springs of Western New-York yield such an abundant supply.

The following is the composition of a portion of sea water taken from the East river at New-York, at very high tide:

Specific gravity 1.02038.

1000 grains contain,

Carbonate of lime,	1.22
Carbonate of magnesia,	0.50
Sulphate of lime,	0.80
Sulphate of magnesia,	1.72
Chloride of magnesium,	2.26
Chloride of sodium (common salt),	20.30
Water, with traces of organic matter,	973.20

This water would require not less than three hundred gallons for the manufacture of a bushel of salt.

On ascending the Hudson, the proportion of saline matter is of course constantly decreasing, until at Newburgh the water scarcely troubles any of the ordinary tests. At the mouth of the Croton river, about forty miles north of New-York, I found the specific gravity of the water at high tide 1.00173, and the proportion of saline matter in 100.000 grs. to be 000.152 grs.; at low tide the specific gravity was 1.00326, and the amount of dry saline matter 000.379 grs. in 100.000 grs. of the water.

An opinion was at one time entertained that the water of Lake Ontario was salt at the bottom, but recent and carefully conducted experiments have proved that such is not the case. It is found, like that of most of our inland lakes and rivers, to be nearly pure, containing only minute quantities of the carbonate and sulphate of lime and chloride of calcium.

CLASS III.

COMBUSTIBLE MINERALS, NOT GASEOUS.

This class includes all the combustible minerals, commonly so called, not already noticed, viz:

1. Sulphur.
2. Bitumen.
3. Amber.
4. Graphite.
5. Anthracite.
6. Coal.
7. Lignite.
8. Peat.

SULPHUR.

Sulphur. *Cleaveland, Phillips* and *Shepard.* — Soufre. *Haüy* and *Beudant.* — Native Sulphur. *Thomson.* — Prismatic Sulphur, or Common Sulphur. *Jameson.* — Prismatischer Schwefel. *Mohs.*

Fig. 14.

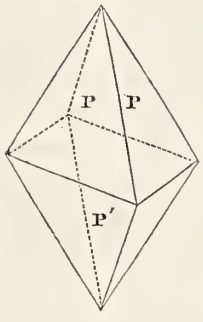
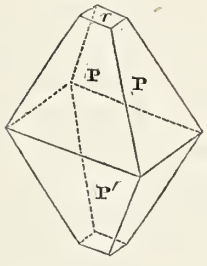


Fig. 15.



Description. Colour when pure, sulphur-yellow; but in consequence of the admixture of foreign matters, it is sometimes red, brown, grey, and even green. Streak white, or sulphur-yellow. It occurs regularly crystallized; also massive, disseminated, stalactitic, and investing other minerals. Primary form an octahedron with a rhombic base. Fig. 14, P on P 106° 38′ and 84° 58′; P on P′ 144° 17′ (*Beudant*). Sometimes the terminal solid angles are replaced by tangent planes, as in Fig. 15. Cleavage imperfect and interrupted. Fracture uneven, splintery or conchoidal. Lustre shining and resinous. Varies from transparent to translucent on the edges. It possesses double refraction in a high degree. Very brittle. Hardness 1.5 to 2.5. Specific gravity from 1.90 to 2.10 (*Phillips*).

When heated and held in the hand, a crackling noise is distinctly heard. It is very fusible, combustible, and even volatile. Burns readily with a blue flame, and is resolved into sulphurous acid by combination with the oxygen of the air, leaving no residuum when the mineral is pure. It acquires resinous electricity by friction.

Geological Situation. Sulphur is most common in volcanic countries. It is sometimes found in primary rocks, but is more frequently associated with the secondary and tertiary ones. It sometimes also results from the decomposition of the compounds of which it forms a constituent.

Uses. This is one of the most important mineral products. It is quite largely employed in the manufacture of sulphur matches; in the preparation of sulphurous acid, which is used to bleach woollen and silken goods; to disinfect vitiated air, etc. Sulphur is also employed for cementing iron bars, and for taking impressions from seals and cameos. But its great uses are in the manufacture of vermilion, gunpower, and oil of vitriol.

LOCALITIES.

Cayuga County. At Thomson's plaster bed in the town of Springport, there are found thin seams of sulphur intermixed with transparent selenite. The sulphur is semi-crystalline, and has all the characters of the volcanic specimens. It does not appear to have been produced by the decomposition of iron pyrites, but it is probably an original deposit.

Small masses of this mineral have also been found in the beds of earthy gypsum near Camillus in Onondaga county, and elsewhere. It is, however, seldom abundant.

Greene County. Some localities are noticed in the Catskill mountains, where this mineral occurs in the fissures of the rocks, with alum, and where it is supposed to have been formed by the decomposition of iron pyrites.

Orange County. Sulphur in a pulverulent form, or in small grains, has occasionally been found in the cavities of a ferruginous granitic rock in the vicinity of West-Point. I have also seen small grains of the same mineral disseminated through porous white quartz from this county. I am at a loss whether to refer these to the decomposition of iron pyrites, or to consider them as original depositions.

In addition to the above localities, it may be stated that in the vicinity of several of our sulphur springs, efflorescences or thin layers of sulphur are found on leaves, twigs, and fragments of rock. In these cases the sulphur is deposited in consequence of the decomposition of the sulphuretted hydrogen which these springs evolve. This is very strikingly the case at the sulphur springs near Chittenango in Madison county, at those of Avon in Livingston county, at Farmington in Ontario county, and at Sharon in Schoharie county. Moss or other vegetables over which these waters flow, become incrusted with sulphur, which, however, is largely mixed with earthy and saline matters.

Sulphur also occurs in various part of the State, as one of the results of the decomposition of iron pyrites. But in these cases, it is seldom sufficiently pure to exhibit the characteristic marks of the mineral.

BITUMEN.

Bitumen. *Cleaveland* and *Shepard*. — Bitume. *Haüy*. — Naphte, with an appendix including Malthe, Asphalte, &c. *Beudant*. — Mineral Oil and Bitumen. *Phillips*. — Asphalte and Elastic Bitumen. *Thomson*. — Black Mineral Resin, Naphtha, Petroleum, Bitumen or Mineral Pitch. *Jameson*. — Schwarzes Erd Harz. *Mohs*.

Description. Colour white, grey, yellow, brown and black. Streak usually unchanged. It occurs massive, disseminated, globular, reniform, stalagmitic and liquid. Fracture con-

choidal, more or less perfect, earthy and slaty. Lustre resinous. Ranges from transparent to opaque. Hardness 0.0 to 2.0. Specific gravity from 0.83 to 1.20. Inflammable, and gives out a bituminous odour when burnt.

Varieties. This species has often been divided into two, under the names of *Mineral Oil*, and *Mineral Pitch* or *Bitumen;* the former of which includes the liquid varieties, and the latter those which are solid. But they imperceptibly pass into each other.

Naphtha. A yellow or yellowish white transparent liquid, which burns with a white flame, and gives out a penetrating odour. It dissolves the resins.

Petroleum. This includes the blackish brown translucent or opaque liquid varieties. It is rather thicker than common tar, emits a thick black smoke when burned, and leaves a black coaly residuum.

Naphtha, when exposed to the air and light, becomes brown, and seems to pass into petroleum: and when petroleum is distilled, a liquid is obtained similar to naphtha.

Mineral Pitch, Asphalt, and *Elastic Bitumen.* These names are sometimes applied to the solid varieties. They are usually of a brownish black colour. The first has an earthy and uneven fracture; the second has a conchoidal fracture, and is opaque and brittle; while elastic bitumen yields easily to pressure, is flexible, elastic, and closely resembles caoutchouc. They all burn readily, giving out much smoke. The soft varieties harden by exposure.

Composition. *Naphtha,* Carbon 82.20, hydrogen 14.80 (*Thomson*). *Elastic Bitumen,* Carbon 52.25, hydrogen 7.49, oxygen 40.10, nitrogen 0.15 (*Henry*). According to Kane, the formula for Asphaltum is $C_{40}H_{32}O_6$.

Geological Situation. Some of the varieties are most abundant in the coal formations, and seem to be connected with them; others are found in limestone and sandstone rocks, and do not appear to be peculiar to any geological period.

Uses. In countries where this mineral abounds, it is frequently used as fuel. Asphaltum enters into the composition of certain hydraulic cements, and into that of the black varnishes called *japans,* for coating iron vessels. Naphtha is employed as a solvent of caoutchouc, and the common petroleum is in repute as a medicinal article.

LOCALITIES.

Albany County. Petroleum is found in considerable quantities, floating on the surface of a spring near McKown's, in the town of Guilderland.

Allegany County. A celebrated locality of petroleum, known by the name of the Seneca Oil Spring, occurs in the town of Cuba, within about eighty rods of the line which divides this county from Cattaraugus, three and a half miles from the village of Cuba, and twenty-one miles from Angelica. It is a circular pool about eighteen feet in diameter, filled nearly to its margin with foul water, and having no visible outlet. The water is coated with a thin layer of the mineral oil, giving it a yellowish brown colour, but the quantity is inconsiderable. The

peculiar odour, however, is perceptible for a considerable distance from the spring.* The substance is collected by skimming it from the fountain, and is used as an external application in various diseases. Indeed so highly was it prized by the Indians, that a mile square around the spring has been reserved for the Senecas. The article, sold under the name of *Seneca oil* in the Eastern and Northern States, is said to be obtained from Oil creek in Venango county, Pennsylvania, where it is not only more abundant, but more pure than at the Cuba spring.

Mr. Hall remarks, that the rocks at Rockville are all highly bituminous; the sandstone so much so, that it scents the clothes of the workmen; and the water of the springs, though clear, has the taste of bitumen.

Cattaraugus County. There is a petroleum or oil spring in the town of Freedom, similar in many respects to that of Cuba in the adjoining county; but its diameter is somewhat less, and the quantity of petroleum which rises to the surface is proportionably the same. It is situated in a bluish aluminous shale similar to that found on the Cattaraugus creek, above Zoar. This shale, which is about twenty-five feet in thickness, rests on a sandstone, which is more highly bituminous than any other rock in the district. In making an excavation of a little more than fourteen feet, about six yards from the spring, pure, glossy, black petroleum, mingled with water, gushed up with great violence. A large quantity of oil was daily removed from this for some time, but afterwards the quantity of oil diminished both in the new and the old springs, and it is now less than it was at the first settlement of the country.†

Chautauque County. The sandstone which occurs at Laona, near Fredonia, has a strong bituminous odour, and not unfrequently contains cavities filled with a liquid resembling petroleum. Thin seams of bituminous coal, or of what seems rather to be indurated petroleum, are found alternating with the strata of slate found at Fredonia and in its vicinity, especially on the shores of Lake Erie. The remarkable evolutions of carburetted hydrogen for which this region is so celebrated, are undoubtedly to be ascribed to the decomposition of these bituminous substances.

Erie County. Springs of petroleum often rise in the shales of this county, especially on the Cauquaga creek. These shales are often so highly charged with bitumen as to burn freely when ignited.

Seneca County. Petroleum is found floating on the surface of Seneca lake, whence the name of *Seneca Oil*, by which it is commonly known. It is also frequently found on the surface of springs in various parts of the county.

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* Vanuxem, *New-York Geological Report*, 1837. † E. N. Horsford, *New-York Geological Reports*, 1840.

AMBER.

Amber. *Cleaveland, Phillips,* and *Thomson.* — Succin. *Haüy* and *Beudant.* — Yellow Mineral Resin, or Amber. *Jameson.* — Gelbes Erd-Harz. *Mohs.*

Description. Colour yellow or yellowish-white, sometimes passing into red brown. Streak white or grey. It occurs in irregular grains, nodules, and sometimes in stalactites; often incloses insects, leaves and other parts of vegetables. Fracture conchoidal. Lustre resinous or vitreous. Transparent and translucent. Brittle, and easily frangible. Hardness from 2.0 to 2.5. Specific gravity from 1.080 to 1.085. When rubbed, it becomes negatively electric. A notice of this fact formed the basis of the science of electricity, the Greek name for amber being ηλεκτρον. It burns with a yellow flame, emits an agreeable odour, and leaves a light shining black coal. It is soluble in alcohol. When distilled, it yields succinic acid.

Amber may be distinguished from gum copal, which it often resembles, by its being harder, and not melting into drops when burning. Mellite or honey-stone becomes white when laid on a red hot coal.

Composition. Carbon 70.68, hydrogen 11.62, oxygen 7.77 (*Ure*). According to Kane, it is a mixture of two resins which are soluble in alcohol and ether, a bitumen insoluble in those liquids, a volatile oil, and the succinic acid.

Geological Situation. Amber usually occurs in alluvial and tertiary formations. It has been found associated with lignite and iron pyrites, at South-Amboy in New-Jersey. The same stratum is continued at Rossville in Richmond county, N. Y., and there is little doubt that amber will be found associated with it. The amber from Amboy occurs in small pale-yellow or reddish-yellow translucent masses. The stratum in which it is found is covered by an astringent clay.

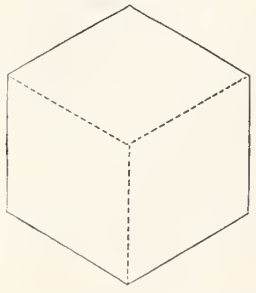
Uses. Amber is very extensively used in the arts as a material for varnishes. It is also employed as a perfume, and the finer kinds are wrought into ornaments which in some countries are highly prized. Its scientific interest depends upon its electrical properties and the results of its distillation.

GRAPHITE.

[From the Greek $\gamma\rho\alpha\varphi\omega$, *I write;* in allusion to its use.]

Graphite. *Haüy* and *Cleaveland.* — Plumbago or Graphite. *Thomson.* — Plumbago. *Phillips* and *Shepard.* — Rhombohedral Graphite. *Jameson.* — Rhomboedrischer Melan-Graphit. *Mohs.*

Fig. 16.



Description. Colour dark steel grey, inclining to iron black. Streak black. It occurs crystallized in regular six-sided tables (Fig. 16); also in granular concretions, massive and disseminated. Primary form a rhombohedron, the dimensions of which are unknown. Cleavage perfect, perpendicular to the axis. Fracture uneven, conchoidal and slaty. Lustre metallic. Opaque. Sectile. Hardness from 1.0 to 2.0. Specific gravity from 2.08 to 2.45. It is infusible by the blow-pipe; but in a high degree of heat, it is combustible, and leaves a residuum of oxide of iron.

Composition. Graphite was for a long time considered as a compound of graphite and iron; but it is now thought that the iron, the proportion of which is very variable, and seldom exceeds ten or eleven per cent., is entirely accidental. The mineral may be regarded as carbon, differing only from the diamond, charcoal, etc., in the mode of aggregation of its ultimate particles.

Geological Situation. This mineral is almost always found in primitive rocks, usually granite or white limestone. In the State of New-York, the latter is the more common matrix, although veins of considerable extent are also found in granite.

Uses. Graphite has long been employed in the manufacture of lead pencils and crayons. It is also used for making crucibles and portable furnaces, for giving a gloss to the surface of iron, and for counteracting friction between rubbing surfaces of wood or metal.

LOCALITIES.

In another part of this work (page 96), I have noticed our principal localities of graphite. A few others may here be added; and to avoid repetition, it may be stated that the white limestone, wherever it occurs, usually contains scales or imperfect tabular crystals of this mineral. The finest specimens of this kind have heretofore been found in the vicinity of Port Henry in Essex county, and in the town of Monroe in the county of Orange. Very fine specimens, having a six-sided form, and exhibiting distinct rhombohedral cleavages, have been found by Dr. Emmons at Johnsburgh in Warren county. But graphite, when it occurs in this manner, is seldom in quantities which render it valuable for economical purposes.

Columbia County. Mr. Mather informs us that graphite is common in the talcose and talco-argillaceous rocks of the Williamstown range; in Hancock mountain, east of New-Lebanon; and east of Hillsdale. Two miles east of the latter a bed has been opened, which

is said to be a mixture of talc and graphite, well suited for some of the uses to which this mineral is applied.*

Essex County. There is a vein of graphite at Rogers' rock, from which tolerable cabinet specimens may be obtained; and a locality of the massive variety has been found near Port Henry, but its extent and value are still unknown.

Putnam County. This mineral, largely mixed, however, with foreign matters, is found associated with arsenical pyrites, near Brown's serpentine quarry, three and a half miles northwest of the village of Carmel.

Orange County. Interesting specimens of graphite occur in the white limestone at Duck Cedar pond, in the town of Monroe. The plates, which are often six-sided or rounded, are stellar and radiated, resembling in their structure certain specimens of prehnite.

New-York County. In the vicinity of the city, graphite has been noticed as occurring in hexahedral prisms about four-tenths of an inch long, and sometimes truncated on their terminal edges. The gangue is a brownish oxide of iron, embracing hornblende and mica.†

Washigton County. A small vein of graphite occurs in the limestone about a mile and a half from Fort-Ann, on the road to Whitehall. It is associated with rounded grains of quartz, pyroxene and other minerals.‡

Artificial Graphite. A kind of graphite is artificially formed during the reduction of the ores of iron. I have found it in the hearth of a furnace at Southfield in Orange county, and at Rossie in St. Lawrence county. At the former, the magnetic, and at the latter, the specular, iron ore, is employed. The specimen from Southfield has the colour and lustre of graphite. It usually breaks with a small conchoidal fracture. It is tougher and harder than graphite, but every where, when broken, has the same lustre and gives the same trace as that mineral. According to my analysis, it is composed of 20.39 carbon and 79.61 iron. On the supposition that this substance contains an atom of each of these constituents, the ratio would be 17.65 carbon and 82.35 iron. One of these artificial compounds, examined by Berthier,§ consisted of 0.183 carbon and 0.819 iron, the proportions being quite near to those in the specimen which I analyzed.

It is known that compounds of carbon and iron in other proportions are thus artificially formed; and sometimes nearly pure graphite is also the result.

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* Mather. *New-York Geological Reports*, 1838.

† Haüy. *Cleaveland's Mineralogy.*

‡ Mather. *New-York Geological Reports*, 1841.

§ *Traité des Essais par la Voie Sèche*, II. 210.

ANTHRACITE.

[From the Greek ανθραξ, *carbon.*]

Anthracite. *Haüy, Cleaveland, Phillips, Thomson* and *Beudant.*— Non-Bituminous Mineral Coal, Glance Coal, Blind Coal, Kilkenny Coal. *Jameson.*— Harzlose Stein-Kohle. *Mohs.*

Description. Colour black, sometimes with a tinge of blue, brown, or grey, and sometimes beautifully iridescent. It seldom exhibits any regular form, although Haüy states that he has met with it in imperfect acute octahedrons, and something of the same kind is said to have been noticed in the anthracite of Pennsylvania; it also occurs massive, vesicular and disseminated. Fracture conchoidal, uneven and slaty. Lustre imperfect, metallic or silky; opaque. Hardness from 2.0 to 2.5. Specific gravity — specimen from Kilkenny, 1.435 (*Thomson*); specimens from Pennsylvania, 1.52 to 1.55. It burns without emitting smoke, and with little or no flame, and leaves a white or reddish coloured ash.

Varieties. The several varieties which are someties known by the names of *Conchoidal, Slaty, Columnar*, and *Fibrous Glance Coal* or *Anthracite*, differ only in the mechanical arrangement of their particles.

Composition. Anthracite, in its pure state, consists almost entirely of carbon. It usually contains a small quantity of water and earthy matters, principally silica and alumina. According to the analysis of Richardson and Regnault, anthracite contains carbon 91.98, hydrogen 3.92, oxygen and nitrogen 3.16, ashes 0.94.

Geological Situation. Anthracite, like the bituminous coal, when it occurs in workable beds, is found only in the secondary rocks; but in smaller quantities, it is found in those of the transition series, as will appear in the following account of our localities. It has already been stated, and is but too well known, that this mineral does not occur in large beds in the State of New-York. There are, however, numerous localities in which there are found thin seams and masses of sufficient size for cabinet specimens. In accordance with the plan of this work, these are to be briefly noticed.

LOCALITIES.

Albany County. Thin seams of anthracite, of a shining black colour, have been found between the layers of greywacke on the banks of the Norman's kill, about two miles south of the city.

Columbia County. The preceding remark will apply to the slate in various parts of this county, which often contains thin layers of anthracite. The slate itself frequently has a black glazing, which gives it the appearance of this mineral. Vast sums have been expended in explorations originating in mistaken notions concerning the nature and geological position of this rock.

Greene County. According to Prof. Eaton, this mineral is found on the Kauterskill, four miles west of Catskill, precisely at the meeting of the cherty limerock with what he has termed the *second greywacke slate*.*

Herkimer County. Anthracite has been found in small veins, traversing the sandstone, in the town of Salisbury. It also occurs at Little-Falls, Middleville and elsewhere, but only in sufficient quantity for cabinet specimens. Masses of several inches in diameter, the largest indeed that have hitherto been found in the State, have been brought from Salisbury. The beautiful quartz crystals for which this county is so celebrated, are often associated with black and shining anthracite, which sometimes adheres to, and penetrates them. The geodes of these crystals are sometimes also lined with a black powder, which is found to be nearly pure carbon. It does not burn with flame, but is gradually consumed under the blowpipe, and leaves a slight earthy residuum. The same black powder is also frequently diffused throughout the entire body of the crystal.

Montgomery County. At Canajoharie and Cherry-Valley, anthracite occurs in thin seams, with associations similar to those which have been noticed under the preceding county. It is also found disseminated in small masses through hornstone, near Spraker's, in the town of Palatine. A considerable sum has been expended in working this locality. The mineral is found in the calciferous sandstone.

Orange County. In the greywacke, it is not unusual to find masses of this mineral from the size of a pin's head to that of a pea, so as to give the rock a handsome appearance. Dr. Horton states that this is strikingly the case at Walden, on the northwest bank of the Walkill.

Rensselaer County. As in the adjoining counties, thin seams of anthracite are sometimes found between the layers of slate.

Schoharie County. Small masses of anthracite have been obtained in Middleburgh, where it is associated with calcareous spar.

Sullivan County. About a mile and a half west of Red bridge, there is a bed of black carbonaceous shale from four and a half to five feet thick, which has thin seams of anthracite interlaminated, from the thickness of paper to that of thick pasteboard. Mr. Mather states that the shale contains vegetable impressions, similar to those found at Carbondale in Pennsylvania. Thin seams of anthracite have also been found in the counties of Ulster, Greene and Schoharie, and occasionally with associated fossil plants. He adds, that although the strata in which these seams of anthracite occur are all perhaps below the coal-bearing rocks of Pennsylvania, and it is not thought probable that coal will be found in useful quantity in them, " still some parts of the upper portions bear so much resemblance to the anthracite coal rocks of Pennsylvania, both in mineralogical character and fossil remains, that it is thought *possible* that coal beds of workable thickness may be discovered."†

It cannot be doubted that other localities of anthracite, similar to the above, exist in various parts of the State, but we have as yet little encouragement to pursue explorations for this important mineral.

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* *American Journal of Science*, XIX. 154.

† Mather. *New-York Geological Reports*, 1840.

COAL.

Coal. *Cleaveland* and *Phillips* — Houille. *Haüy* and *Beudant.* — Bituminous Mineral Coal. *Thompson* and *Jameson.* — Harzige Stein-Kohle. *Mohs.*

Description. Colour black or brown, often with an iridescent tarnish. Streak shining. It occurs massive, ligniform, and rarely in columnar concretions. Fracture earthy, conchoidal, slaty and uneven. Lustre resinous or semi-metallic. Opaque. Sectile or brittle. Hardness from 1.0 to 2.5. Specific gravity from 1.20 to 1.30. It burns with a whitish flame, yielding much smoke and a feeble bituminous odour; the products of the combustion being chiefly carbonic acid, water, and a little sulphurous acid. It often contains also some earthy matters.

Varieties. There are several varieties of this mineral, as *Slate coal*, *Cannel coal*, *Foliated coal*, *Pitch coal*, etc., but they are seldom observed in our limited localities.

Composition. *Newcastle Coal*—Carbon 75.28, hydrogen 4.18, nitrogen 15.96, oxygen 4.58 (*Thomson*).

Cannel Coal—Carbon 83.75, hydrogen 5.66, oxygen and nitrogen 8.04, ashes 2.55 (*Richardson* and *Regnault*).

Splint Coal—Carbon 82.92, hydrogen 6.49, oxygen and nitrogen 10.86, ashes 0.13 (*Richardson* and *Regnault*).

Geological Situation. When in workable beds, it is similar to the preceding; but in thin veins and small masses, it is found in lower series of rocks.

localities.

Chautauque County. The bituminous slate through which the carburetted hydrogen gas issues in the vicinity of Fredonia, and elsewhere in this county, often contains thin seams of coal, which burns freely, and of course is of the bituminous kind. It seems, however, to be either wholly or in part composed of a hardened petroleum, as it gives out a stronger odour than any of the varieties of coal with which I am acquainted. Sometimes these seams are several inches in thickness, and from some of the excavations a bushel or more of the coal has been obtained.

Erie County. The pyritous shale, which abounds here, contains thin layers of coal similar to those found in the preceding county, and the same remark applies to similar formations in the counties of Madison and Onondaga.

Thin seams of this mineral have also been observed in the counties of Livingston and Seneca. In the latter, they are from a quarter of an inch to two inches in thickness, and occur between the strata of shale and sandstone.

Ulster County. In the town of Woodstock, on the eastern face of the Catskill mountain, a vein of coal was found, about eight inches thick, and it extended for some distance on the

face of the ledge. On making an excavation, the coal widened to twenty-two inches; but it then diminished to a narrow seam, and the working was abandoned. This locality was about a thousand feet above the Hudson. The coal is said to be light and shining, and it burns with a moderate flame. Other veins of a similar kind have been noticed in the same range.*

LIGNITE.

[From the Latin *lignum, wood;* in allusion to its origin.]

Lignite. *Cleaveland* and *Beudant.* — Wood Coal. *Thomson.*

Description. This mineral, which is often described as a variety of coal, still differs considerably from it. All its varieties have undoubtedly originated from wood, and the process of change has probably taken place at a period not very remote. In most cases the texture of the wood is preserved, and it burns exactly as wood does, leaving a residue of ashes, but often more abundant.

The odour which lignite exhales is different from that of burning coal or bitumen. It is usually unpleasant, sometimes sharp or fetid. It also differs from coal, in yielding, when subjected to distillation, a peculiar acid liquor.

Varieties. *Jet.* This is deep black, opaque, and so solid and hard that it may be turned on a lathe. Fracture conchoidal. Lustre resinous.

Brittle Lignite. Differs from jet, by its great brittleness. Colour black, with a shade of brown. It is less shining than jet. The surface is easily divisible into cubical or trapezoidal fragments.

Bituminous Wood. This is made up of the roots, branches or trunks of trees, usually somewhat compressed. Texture ligneous, with little lustre. Colour brown, or brownish black.

Composition. Carbon 71.71, hydrogen 4.85, oxygen and nitrogen 21.67, ashes 1.77 (*Richardson* and *Regnault*).

Geological Situation. Lignite is usually found in the more recent formations. When in sufficient abundance, it is converted to the same uses as coal and anthracite; but this is seldom the case.

LOCALITIES.

Richmond County. Near Rossville is a stratum of lignite from three to six inches thick, near or below high water mark. Sometimes the mineral has the colour and appearance of wood slightly charred; at others, it is quite compact, has a dark brown or nearly black colour, and resembles jet. Crystals of iron pyrites occur in the fissures of the lignite, and these are

* J. Pierce. *American Journal of Science,* VI. 86.

often of great beauty; but after a short exposure to the air, they are usually converted into sulphate of iron. The stratum of lignite is imbedded in a dark blue astringent clay, which contains a large proportion of pyrites in nodules and grains. When this is exposed to the air for a time, it acquires a green efflorescence of sulphate of iron.

Lignite occurs with similar associates in various parts of Suffolk county; but neither here, nor in Richmond, has it been found in quantities sufficient for fuel.

So far as my observation extends, the masses of lignite are accompanied by fragments of wood which have undergone no alteration whatever, except what may be ascribed to the mechanical action of the water to which they are constantly exposed.

A minute examination of the Rossville locality has satisfied me that the change of this drift wood into lignite is due to the action of sulphuric acid contained in the clay, so similar are many of the specimens in their appearance to the charred vegetable matter found at the celebrated sour spring in Byron, Genesee county. I subsequently ascertained that the same view had been broached by Dr. Emmons, in a notice of the lignite of New-Jersey. The facts which he adduces in its support are, 1st, that the charring seems to be of recent occurrence; 2d, that there is a difference in the change which different fragments have undergone, from being unequally exposed to the action of the acid; 3d, that free sulphuric acid may be detected in the small streams flowing down the banks, produced by the decomposition of the iron pyrites; and 4th, That the charring is most perfect where the pyrites is most abundant, and where this mineral is wholly wanting, no carbonization is perceptible.*

This interesting process, as above suggested, has no doubt taken place recently, and is indeed perhaps daily going forward. The sulphuric acid or acid sulphate of iron contained in the clay, acting upon the strata of drift wood which are thrown upon the bank, causes a partial or entire carbonization. The carbon thus formed, again reacts upon a portion of the sulphate, and by abstracting its oxygen, gives rise to iron pyrites or peroxide of iron, depending upon the extent to which the decomposing action has been carried.

It is worthy of notice, also, that small masses of amber are found associated with the lignite. As this mineral has been proved by Sir David Brewster to be of vegetable origin, and is perhaps the hardened juice of certain trees, can its formation be ascribed to the same cause to which that of the lignite has now been referred?

I will only add, that localities of lignite have been noticed in Dutchess and Columbia counties, by Mr. Finch; and by Dr. Emmons, in those of Essex and Warren.

PEAT.

Peat. *Cleaveland.* — Tourbe. *Beudant.* — Turf *of the English.* — Torf *of the Germans.*

Description. Colour brown, sometimes yellowish or reddish, or dull black. It has a loose texture, more or less porous, or even spongy. When recently dug, it forms a viscid slimy mass, which, by exposure to the air, becomes dry, hard, and more or less brittle.

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* *American Journal of Science*, XXIII. 371.

This substance burns with different degrees of ease, but sufficiently well to be employed as fuel. On this account, it may hereafter become an article of great importance.

Peat or turf is vegetable matter in various states of decomposition, but it is more or less mixed with earths and salts. Although it contains all the principles of the vegetable, these principles may have formed combinations which do not exist in the living plant.

Composition. This varies considerably in different specimens. According to Davy, one hundred parts of dry peat contain from 60 to 99 parts of matter destructible by heat, the remainder consisting of earthy substances and salts. Its constituents, according to Richardson and Regnault, are carbon 58.09, hydrogen 5.93, oxygen and nitrogen 31.37, ashes 4.61.

Geological Situation. In the former part of this work (page 95), where peat is treated of among the useful minerals, I have given some facts in regard to the mode of its formation, which it is not necessary to repeat. It has also been observed that it usually accompanies, or rather forms the basis of, shell marl, being usually found in swamps and bogs. I will here only notice the principal localities, and, for further details, refer to the articles Marl and Peat, already introduced.

LOCALITIES.

Cattaraugus County. In the towns of Great-Valley and Little-Valley, the *sags* or depressions in which the clay is formed, contain more or less extensive bodies of peat. Mr. Horsford states that the largest of these is on the land of Mr. Sweatland. The bog has an area of about ten acres; and the depth of peat varies from a foot or two near the margin, to twelve feet towards the centre.*

Columbia and Dutchess Counties. Mr. Mather, in his report for 1838, enumerates many localities of peat in several towns of these counties, as Kinderhook, New-Lebanon, Ghent, Fishkill, Hillsdale, Dover, Amenia, Copake, Ancram, Pine-Plains, Rhinebeck, Northeast and Clinton.

Hamilton County. There is said to be an inexhaustible quantity of peat on a stream which Dr. Emmons calls *Marion river*, and which connects the Eckford lakes with Racket lake. It also occurs elsewhere in this region.†

Clinton County. Dr. Emmons states that a very large collection of this substance occurs in the western part of the town of Champlain. The marsh is about two and a half miles in length, and from a half to three quarters of a mile wide. He supposes the peat to extend throughout the whole of this area, to the depth of from twelve to thirty or more feet. He also states that there are peat bogs of equal extent in other parts of the county.‡

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* *New-York Geological Reports*, 1840. † Emmons. *New-York Geological Reports*, 1841. ‡ Ib. 1839.

Kings, Queens and Richmond Counties. Peat is found in various parts of these counties, but not in remarkably extensive deposits. The most important localities are near Newtown, where it is said to have been dug for fifty years. It is used as fuel, and its ashes has been successfully employed as a fertilizer.

Orange County. This substance is said to exist in great abundance in every town, except Deerpark, and the quantity is perfectly inexhaustible. Among the particular localities may be enumerated several swamps near Fort Montgomery, one near Crossway mine, and another east of Sterling mine. To these may be added the Drowned lands, the Greycourt meadows and the Black meadows, which are underlaid with peat.

Otsego County. A few deposits of peat have been discovered in this county. Among these may be mentioned a swamp two miles south of Cooperstown, and several smaller ones in the same vicinity. On the road from Cooperstown west towards Oakville, are several small deposits.*

Putnam County. Mr. Mather enumerates several peat bogs which occur in this county. One lies near the east side of Mahopack pond; another, very large, near Patterson; another in Phillipstown, about two miles east-northeast of West-Point; and there is still another near Davenport's corners, five miles northeast of Coldspring.†

Rockland County. This is no less plentifully supplied with peat than the adjoining county (Orange). There is a bog about a mile south of the Long Clove; another, two miles west of Nyack, containing fifty or more acres; another, of about forty acres, a mile southwest of Snediker's landing. On the mountain near the turnpike from the village of Haverstraw to Monroe works, several bogs are found of considerable extent; and besides these, many others are said, by Mr. Mather, to exist in this county.

In Sullivan and Ulster counties, several peat bogs have already been discovered.

Warren County. There is an important locality of this substance on the farm of Mr. Richards, in Warrensburgh. It is said to cover about sixty acres, and to extend to a depth of sixty feet. According to Dr. Emmons, several smaller deposits are found in the towns of Schroon, Chester, Warrensburgh, Johnsburgh, Queensbury, Lake-Pleasant and Wells, varying in extent from one to five acres.

Westchester County. The meadow east of Verplank is filled with peat to a great depth. A quarter of a mile west of Bedford, is a bog of several acres in extent; another occurs on Mr. Underhill's farm, two and a half miles south of Crumpond village; another, of one hundred and fifty acres, east of Croton, and about four miles southeast of Somerstown plains.† Besides these, there are still other localities, which, however, do not require to be particularly noticed.

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* Vanuxem. *New-York Geological Reports*, 1840.

† Mather. *New-York Geological Reports*, 1839.

CLASS IV.

ALKALINE MINERALS.

The minerals of this class contain one or more of the common alkalies, Ammonia, Potash or Soda, usually combined with an acid.

ORDER I. AMMONIA.

1. Carbonate of Ammonia.

CARBONATE OF AMMONIA.

The carbonate of ammonia has been detected in the water of a spring in the city of New-York, which was analyzed many years since by the late Mr. George Chilton.* Its occurrence, although rare, is not entirely new, as it has been found by Professor Fischer in the thermal water of Warmbrunn in Silesia; by Wetzler, in the cold spring of Krumbach in Bavaria; and by Kastner, in that of Kissingen, in the same kingdom.† Dr. Daubeny supposes that it may be of still more frequent occurrence, and that chemists have perhaps overlooked its presence, in consequence of having driven it off by the heat, which, in analyzing the water, they had in the first instance applied.

Carbonate of ammonia is also occasionally found in rain water, as has recently been shown by Liebig and others; the ammonia being formed by the decomposition of various animal and vegetable matters, taken into the atmosphere, combined with the carbonic acid which there exists, and finally brought down by rain and snow.

The presence of this salt may be determined by the effervescence which is produced when it is treated with sulphuric acid, and by the strong ammoniacal odour which is evolved when it is mixed in a mortar with pure potash or quicklime.

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* *American Journal of Science*, XVIII. 346.

† Daubeny. *Report on Mineral and Thermal Waters.*

ORDER II. SODA.

1. Glauber's Salt.
2. Natron.
3. Common Salt.
4. Hydriodate of Soda.

GLAUBER'S SALT.

[Named after its discoverer, I. R. Glauber, an alchemist of the 17th century.]

Soudé Sulphaté. *Haüy.* — Sulphate of Soda. *Cleaveland* and *Phillips.* — Hydrous Sulphate of Soda. *Thomson.* — Glauber Salt. *Shepard* and *Dana.* — Prismatic Glauber Salt. *Jameson.* — Prismatisches Glauber Salz. *Mohs.* — Exanthalose. *Beudant.*

Fig. 17.

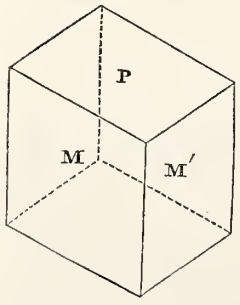
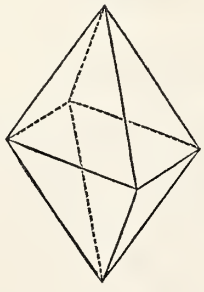


Fig. 18.



Description. This mineral usually occurs in the form of a white efflorescence. It has a bitter taste, is soluble in water, and the solution gives, on evaporation, crystals which have the form of four or six-sided prisms, but the primary of which is an oblique rhombic prism of 99° 36′ and 80° 24′ (*Phillips*), (Fig. 17). According to Haüy and others, it is an octahedron with a rhombic base (Fig. 18). These crystals soon fall into powder on exposure to the air. When heated, they undergo watery fusion. Lustre vitreous on fresh fracture. Hardness from 1.5 to 2.0. Specific gravity 1.47.

From common salt, it may be distinguished by the copious precipitate which is produced in its solution by chloride of barium. It is less bitter than sulphate of magnesia, and the latter salt yields a copious precipitate when it is treated with a pure or carbonated alkali. Sulphate of potash affords a yellow precipitate with chloride of platinum, which is not the case with Glauber's salt.

Composition. *A specimen from Vesuvius*—Sulphuric acid 44.8, soda 35.0, water 20.2 (*Beudant*). This is in the ratio of one proportion of the salt to two proportions of water, and the formula is $NaO.SO_3+2Aq$.

Uses. This salt, which is extensively prepared by artificial means, is employed in glass-making, and in the manufacture of the subcarbonate of soda. It is also used in medicine, and promises to be an article of great value in agriculture.

LOCALITIES.

Glauber's salt seldom occurs in regular crystals, but is found, with various impurities, in the form of efflorescences on soils and rocks of various descriptions. It sometimes also occurs

in solution in mineral springs, and is often one of the ingredients of sea water. In some cases it accompanies the carbonate of soda, when its occurrence may be referred to the mutual decomposition of common salt and sulphate of magnesia. This action is especially observed at low temperatures: it is in winter that Glauber's salt is found in the greatest quantity in certain lakes.*

This salt, mixed however with various other saline matters, is found in the form of an efflorescence on the limestone below the Genesee falls at Rochester, in Monroe county. It is also held in solution by the water of the Longmuir spring, in the city of Rochester.

NATRON.

[From the desert of *Natron*, where it was formerly obtained.]

Soda Carbonatée. *Haüy.* — Carbonate of Soda. *Cleaveland* and *Phillips.* — Hemiprismatic Natron. *Jameson.* — Hemiprismatisches Natron-Salz. *Mohs.* — Natron. *Beudant*, *Shepard* and *Dana.*

Fig. 19.

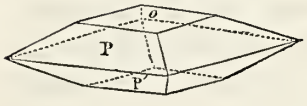
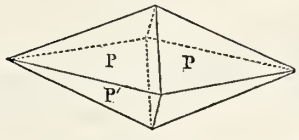


Fig. 20.



Description. A saline substance, usually occurrring effloresced and in powder; but it is easily crystallized artificially, when it assumes the form of the octahedron with a rhombic base, truncated at the summit (Fig. 19). The primary form, according to Haüy, is that represented in Fig. 20. P on P 143° 8′; P on P′ 113° 54′.

Natron has an alkaline reäction, effervesces with acids, and is soluble in about two parts of cold water. It gives the flame of alcohol a yellow tint, by which it can be distinguished from carbonate of potash. The crystals of natron effloresce in the air; those of trona do not.

Composition. When entirely pure, it contains carbonic acid 32.30, soda 46.70, water 14.00, but it is almost always mixed with portions of sulphate of soda and common salt. Its formula is $NaCO_2+Aq$.

Uses. This salt is largely employed in the manufacture of soap and glass. It is now prepared artificially by the decomposition of Glauber's salt.

LOCALITIES.

This salt occurs in needleform efflorescing crystals on walls in the cities of New-York and Albany, where it is probably produced by the reciprocal action of carbonate of lime and common salt. The fact that such a mutual decomposition does take place, was first proved by Berthollet, who carefully examined the subject, and communicated the results of his observa-

* Beudant. *Traité Elémentaire de Minéralogie*, I. 647.

tions to the Institute of Egypt. It was in consequence of the views of this celebrated chemist, that the manufacture of carbonate of soda from common salt, now so extensively carried on, was first established.

COMMON SALT.

Soude Muriatée. *Haüy.* — Muriate of Soda. *Cleaveland* and *Phillips.* — Hexahedral Rock-Salt. *Jameson.* — Hexaedrisches Steinsalz. *Mohs.* — Salmare. *Beudant.* — Common Salt. *Shepard* and *Dana.* — Chloride of Sodium, *of Chemists.*

Description. Color usually grey or white; sometimes also blue, red, yellow and green. It occurs in granular, fibrous, radiated and prismatic concretions; also massive, dentiform and stalactitic. Lustre between vitreous and resinous. More or less transparent and translucent. Hardness 2.0. Specific gravity from 2.12 to 2.30.

Fig. 21.

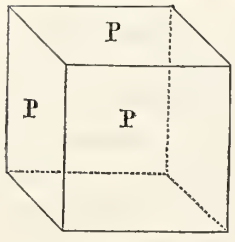
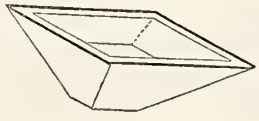


Fig. 22.



Common salt is soluble in twice its weight of water at 60° Fahr., and is but little more soluble in hot water. From this solution, regular cubes (Fig. 21) of a white colour may be obtained by spontaneous evaporation; or if heat be applied to the solution, and then withdrawn, it forms hollow quadrangular pyramids, resembling Fig. 22. These crystals are but little changed by exposure to the atmosphere. When treated with sulphuric acid, muriatic acid is disengaged, and there remain after evaporation crystals of Glauber's salt, which effloresce on exposure to the atmosphere. The solution of this salt in water gives no precipitate with chloride of barium or alkalies, but an abundant one with nitrate of silver.

Composition. In its pure form, it contains chlorine 60.34, sodium 39.66; but whether obtained in the form of rock salt, or by evaporation from brine springs or sea water, it is usually mixed with the chlorides of calcium and magnesium, the sulphates of soda, magnesia and lime, and frequently also with earthy matters. Its formula is NaCl.

Geological Situation. It occurs in beds, imbedded masses and veins, associated with saliniferous clay, gypsum, limestone, sandstone and anhydrite, in the *salt formation;* also in layers and crusts on soils of particular kinds, and deposited on the shores of salt lakes, and in the vicinity of salt springs.

Uses. The principal uses of common salt are well known. In addition to these, it is now largely employed in the manufacture of sulphate and carbonate of soda, chloride of lime, etc.

LOCALITIES.

This mineral has not yet been found in its solid or fossil form in this State, although it exists largely in solution. I have elsewhere given the reasons which lead me to believe that the brine springs of Onondaga county have their origin in beds of this mineral (pages 119 et seq.)

The most important brine springs in the State are those of Onondaga county, where salt has been for many years extensively manufactured. In some cases the water of these springs contains from eighteen to nineteen per cent. of saline matter, of which upwards of seventeen per cent. is pure common salt. Besides this last, the water of these springs contains carbonate and sulphate of lime, chlorides of calcium and magnesium, oxide of iron, silica and organic matter, with some compound containing bromine; all, however, in small and variable proportions.

I have already given a full account of the localities of our brine springs, the mode of manufacturing salt, etc., for which the reader is referred to page 99. I will only add, that common salt is one of the ingredients of those efflorescences which are found on the limestone near Rochester, in Monroe county.

Since the preceding part of my Report has passed through the press, I have analyzed a brine from a boring of upwards of five hundred feet, at the village of Montezuma, and which is remarkable for the large proportion of saline matter which it contains. The specific gravity of this brine is 1.18959, water being 1.00000. 1000 grains of the brine contain 230.30 grains of perfectly dry saline matter. The strength of the specimen may be judged of by the fact, that 1000 grains of water entirely saturated with common salt, contain from 260 to 270 grains of that salt; so that if there were nothing in this brine but common salt, it would be within three or four per cent. of complete saturation: but this is far from being the case.

The following are the constituents in 1000 grains of this brine:

Sulphate of lime, with a minute portion of carbonate of lime and oxide of iron,	0.69
Chloride of calcium,	90.24
Chloride of magnesium,	8.05
Common salt (pure and dry),	131.32
Water, with traces of organic matter,	769.70

It will require from forty-three to forty-five gallons of this brine to furnish a bushel of salt in the ordinary state of dryness.

The following statement will exhibit the value of this brine, as compared with the best specimens heretofore obtained from Syracuse and from Montezuma:

	GRAINS.
Proportion of common salt in 100 grains of this brine,	13.13
Ditto ditto in 100 grs. best Syracuse brine,	17.35
Ditto ditto in 100 grs. best Montezuma brine,	9.33

But in regard to troublesome impurities, viz. the chlorides of calcium and magnesium, the proportion in the brine just described is much larger, as will appear from the following statement:

	GRAINS.
Earthy chlorides in 100 grains of this brine,	9.82
Ditto in 100 grs. best Syracuse brine,	1.50
Ditto in 100 grs. best Montezuma brine,	2.40

The manufacture of salt from this brine, therefore, will require more than ordinary care; as the earthy chlorides, even in small proportions, render it moist, and unfit for certain uses.

The following is a summary of the most important facts in regard to this brine:

1. It is the most highly charged mineral water heretofore found in the State.
2. It contains a larger proportion of common salt than any of the brines previously obtained at Montezuma.
3. The impurities are in much larger proportion than in any of our brines.

HYDRIODATE OF SODA.

This salt, more properly perhaps the Iodide of Sodium, which exists in many of the foreign springs, has been detected in some of those at Saratoga. It is one of the ingredients which is supposed to impart peculiar medicinal virtues to these waters.

Description. A neutral compound, deliquescent in the air, soluble in water and alcohol. It fuses readily by heat, and is volatile, though less so than iodide of potassium. When its solution is evaporated at the temperature of about 123° Fahr., it crystallizes in cubes, which, according to Berzelius, contain 20.23 per cent. of water.

The presence of iodine in this salt may be determined by adding to its solution, previously acidulated with sulphuric acid, a cold solution of starch. A deep blue precipitate will be produced, if any iodine is present.

The *Hydrobromate of Soda*, or *Bromide of Sodium*, has been detected in several of the foreign springs, and probably exists in the brine springs of Onondaga county, as bromine is known to be one of their constituents. It is found only in very minute proportions.

ORDER III. POTASH.

1. Sulphate of Potash.
2. Carbonate of Potash.
3. Muriate of Potash.
4. Hydrobromate of Potash.
5. Alum.

SULPHATE OF POTASH.

Potasse Sulfatée. *Haüy.* — Aphthalose. *Beudant.*

This salt has been found in some mineral waters, and was formerly thought to be one of the ingredients of the Salina brine. It also occurs among the products of volcanoes.

Fig. 23.

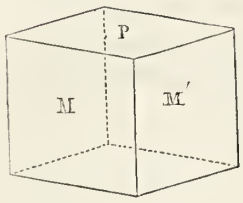


Fig. 24.

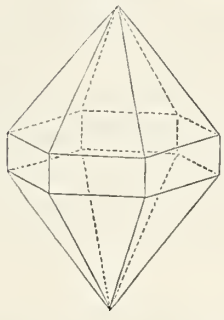
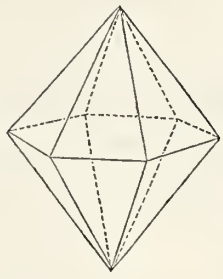


Fig. 25.



Description. Colour white. Taste slightly bitter. It crystallizes from its solution in the form of the right rhombic prism, which is the primary. Fig. 23. M on M′ 118° 8′ (*Beudant.*) It also occurs in short six-sided prisms terminated by six-sided pyramids, Fig. 24; and in dodecahedrons, Fig. 25. It does not contain water, and suffers no change on exposure to the air; decrepitates when heated, and enters into fusion at a red heat. 100 parts of water dissolve 8.3 of the salt at 32° Fahr., and 25 parts at 212° Fahr. Specific gravity 2.40.

The solution of this salt causes a yellow precipitate when treated with chloride of platinum, by which it may be distinguished from the sulphate of soda, and indeed from all the salts of that alkali.

Composition. Sulphuric acid 45.95, potash 54.07 (*Beudant.*) Formula $KO.SO_3$. This salt, as well as the bisulphate of potash, is procured in large quantities in the manufacture of sulphuric and nitric acids, where nitrate of potash is employed.

CARBONATE OF POTASH.

This salt has been found in the water of certain springs, but only in very small quantities. It is introduced here chiefly for the purpose of directing the attention of future observers to ascertaining whether it exists in our waters.

Carbonate of potash exists in the ashes of plants, and, mixed with small proportions of other salts, constitutes the *Potash* and *Pearlash* of commerce. Formula KO.CO.

MURIATE OF POTASH.

Chloride of Potassium, *of Chemists.*

Description. This salt occurs in cubic crystals, which have a saline and bitter taste, and are destitute of water. It is soluble in three parts of water at 60° Fahr., producing so much cold as to be employed as a freezing mixture.

Composition. Potassium 52.60, chlorine 47.40; the formula being KCl.

Chloride of potassium exists in the water of many brine springs, in sea water, and in the ashes of plants. Its principal use is in the manufacture of alum.

HYDROBROMATE OF POTASSA.

Bromide of Potassium, *of Chemists.*

Description. This salt, which has been detected in very minute quantities in the Saratoga waters, crystallizes in cubes or in rectangular prisms. The crystals being destitute of water, decrepitate when heated, and enter into fusion without suffering any change. It is very soluble in water, and slightly so in alcohol. It may be recognized, by giving, with oil of vitriol, orange red fumes of bromine.

Composition. Potassium 33.42, and bromine 66.58. Formula KBr.

ALUM.

[From its containing *alumina.*]

Alumine Sulfatée Alkaline. *Haüy.* — Sulphate of Alumine and Potash. *Cleaveland.* — Alum. *Phillips* and *Shepard.* — Native Alum. *Dana.* — Potash Alum. *Thomson.* — Octahedral Alum. *Jameson.* — Octaedrisches Alaun-Salz. *Mohs.*

Fig. 26.

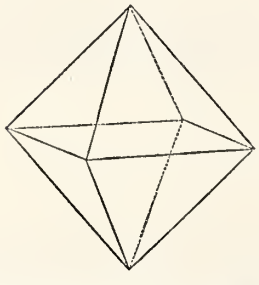


Fig. 27.

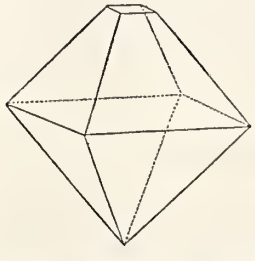
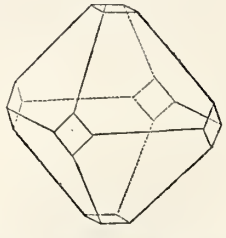


Fig. 28.



Description. Colour white or greyish. It occurs in crystals; but more frequently in farinaceous effloresences on argillaceous minerals, or in concretions, stalactites, and fibrous masses. When artificially prepared, it crystallizes in the octahedron, Fig. 26, which is its

primary form; or in some of its varieties, as Fig. 27 and 28. Lustre, when crystallized, vitreous; if delicately fibrous, pearly. Transparent to translucent. Hardness from 2.0 to 2.5. Specific gravity 1.75. Taste sweetish and astringent. Very soluble in water, and the solution gives a white precipitate with carbonate of potash. When exposed to heat, it melts in its own water of crystallization, froths up in a remarkable manner, and is converted into a spongiform mass of anhydrous alum. It gives a violet colour to the flame of the blow-pipe.

Composition. Potash 10.10, alumina 10.80, sulphuric acid 33.70, water 45.40 (*Gmelin*). The formula of the artificial salt, according to Kane, is $(KO.SO_3+Al_3O_3+3SO_3)+24Aq$.

Geological Situation. Alum is generally found incrusting various kinds of slates and shales.

Uses. It is extensively manufactured, being largely used in dyeing, lake-making, dressing sheep skins, clarifying liquors, etc.

LOCALITIES.

This salt is found in efflorescences in various parts of the State. It is often met with on the Hudson river slate, as in Albany, Columbia, Saratoga and Oneida counties.

In Ulster County, on the Catskill mountain, in argillaceous sandstone, extending four miles north of the Clove passage; also in the same mountain, southwest from Cairo, where it is stalactitical.* It also occurs in efflorescences in the Shawangunk mountains, and elsewhere in the county.

Chautauque County. Alum earth is found in the town of Sheridan, from which alum is formed by the action of the atmosphere. It is not, however, thought to be abundant.

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* J. Pierce. *American Journal of Science*, VI. 86.

CLASS V.

ALKALINE-EARTHY MINERALS.

Composed of one or more alkaline earths, Baryta, Strontia, Lime or Magnesia, combined with water or an acid, and frequently containing some metallic oxide.

ORDER I. BARYTA.

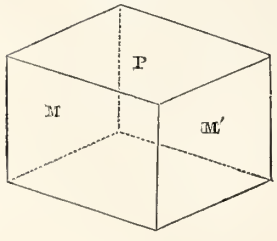
1. Heavy Spar.

HEAVY SPAR.

[From its great specific gravity, as compared with other non-metallic minerals.]

Baryte Sulfatée. *Haüy*, — Sulphate of Barytes. *Cleaveland* and *Thomson*. — Prismatic Heavy Spar. *Jameson*. — Prismatischer Hal-Baryte. *Mohs*. — Barytes. *Phillips*. — Barytine. *Beudant*. — Heavy Spar. *Shepard* and *Dana*.

Fig. 29.



Description. Colour, when pure, snow white; but it is sometimes grey, black, blue, green, yellow, red and brown. It occurs regularly crystallized, also massive and disseminated. Primary form a right rhombic prism. Fig. 29. M on M′ 101° 42′. Cleavage parallel to M and M′, perfect. Fracture uneven, splintery and earthy. Lustre resinous or pearly, inclining to vitreous. From transparent to opaque. Brittle and very easily frangible. Hardness from 3.0 to 3.5. Specific gravity from 4.30 to 4.70. Before the blowpipe, it decrepitates, and is with difficulty fused into a white enamel. With soda, it is converted into sulphuret of barium, which, when dissolved in a dilute acid, gives out sulphuretted hydrogen.

When pure, the great specific gravity will usually distinguish this mineral from others which it resembles. Celestine, when held for some time in the reducing flame, and then moistened with a drop of muriatic acid and held to the blue part of a candle flame, colours it beautifully purple; which is not the case with heavy spar. Witherite and strontianite dissolve with effervescence in muriatic acid, while heavy spar is not acted on by it. It is, however, in some cases quite difficult, without a detailed analysis, to distinguish between the salts of baryta and the corresponding ones of strontia.

Composition. Sulphuric acid 34.00, baryta 66.00. But it often contains foreign substances. Formula $BaO.SO_3$.

Uses. Heavy spar may be employed for obtaining the other salts of baryta. It is also of considerable value as a paint. When it is of a white colour, it may be used as a substitute for white lead, for ordinary purposes. The white lead of commerce is often adulterated with it, and it is extremely difficult to detect the adulteration (see page 61). It is, moreover, sometimes employed as a flux.

Geological Situation. It usually occurs in veins, either alone, or associated with various metalliferous formations of silver, copper, lead, etc. In this State, it is most commonly associated with calcareous spar, forming small veins or geodes.

LOCALITIES.

Columbia County. At the Ancram lead mine, it has been found in veins of considerable thickness in the slate and limestone. It is of a white colour, and massive. I am not aware that it h asbeen obtained here in the form of crystals.

Greene County. It is said to have been found in Catskill, two miles east of the mountains, associated with carbonate of copper and quartz;* but I have no knowledge of the locality.

Herkimer County. Near the villages of Little-Falls and Fairfield, lamellar masses of heavy spar are found, having a yellowish white colour. When rubbed to powder in a mortar, it gives out a strong smell of sulphuretted hydrogen. It has been noticed as a distinct variety, under the name of *Fetid Heavy Spar.*

In the calciferous sandrock on the south side of the Mohawk, opposite Little-Falls, there occur veins and geodes of this mineral in a crystallized form. The colours are white and bluish-white; and it is sometimes translucent, or nearly transparent. The specimens are fetid when rubbed or struck briskly with a hammer. The accompanying figures represent the crystalline forms which have here been observed.

Fig. 30. Fig. 31. Fig. 32.

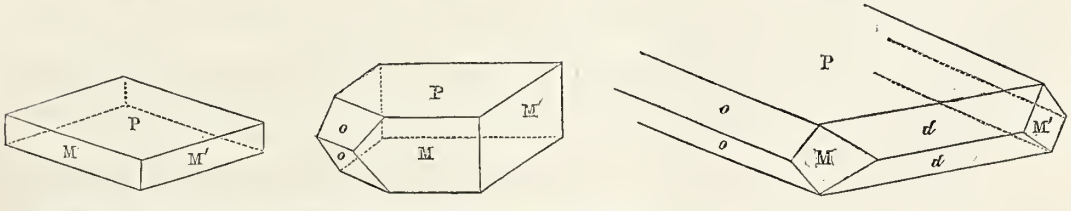


Fig. 30. A minute flattened table of the primary form.

Fig. 31. The primary, with two acute solid angles replaced by planes. P on *o* 137° 5′ 13″; *o* on *o* 105° 49′ 34″ (*Haüy*).

Fig. 32, *épointée* of Haüy. P on *d* 140° 59′ 21″; *d* on *d* 78° 1′ 58″.

* *American Journal of Science*, IV. 250.

Fig. 33.

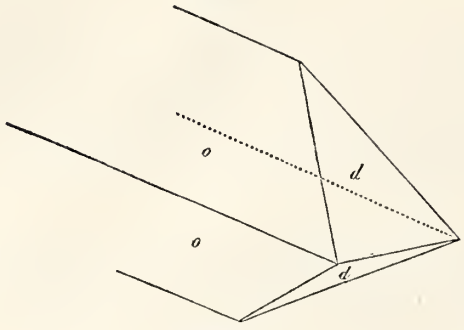


Fig. 34.

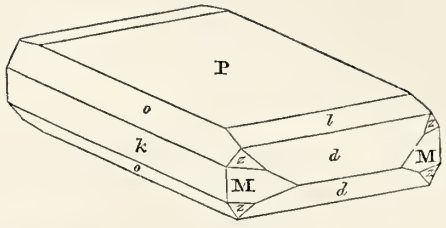


Fig. 35.

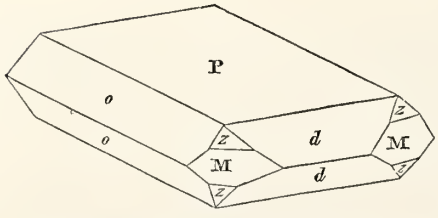


Fig. 33, *unibinaire* of Haüy.

Fig. 34. A modification of the *amblifère* of Haüy. M on z 154° 26′ 52″; z on z 110° 25′ 58″; o on z 135° 39′ 58″.

Fig. 35, *sousquadruple* of Haüy. M on k 129° 13′ 54″; k on o 142° 8′ 47″; P on l 157° 56′ 59″; d on l 163° 2′ 22″.

Jefferson County. At Pillar point, on the shore of Lake Ontario, a few miles northeast of Sacket's-Harbor, heavy spar forms large veins, and may be taken out in blocks two or three feet in length and a foot or more in width. It is nearly compact, variously coloured, and susceptible of a high degree of polish.

According to Dr. Emmons, coralloidal heavy spar is found associated with calcareous spar at Oxbow in this county.

Monroe County. In the limestone near Rochester, there have been found nodules either fibrous or lamellar, and of a reddish colour. The same variety occurs crystallized, in Wayne county; but it has not been thus obtained at this locality. It has sometimes been mistaken for sulphate of strontia.

Madison County. Mr. Eaton states that this mineral occurs about a mile from the great water limestone quarry.

Montgomery County. The lamellar variety, similar to that of Little-Falls and Fairfield, has been found in loose masses in several parts of this county. It probably belongs to the calciferous sandrock.

Onondaga County. About three quarters of a mile east of the Railroad depot at Syracuse, heavy spar occurs in plates or tables interlacing each other, in the limestone. Celestine is also found at the same locality, and both of these minerals are in the immediate vicinity of the dyke of serpentine, first noticed by Mr. Vanuxem, and which will be described in its proper place.

Rockland County. Minute tabular crystals, having the primary form, are found associated with calcareous spar at Tompkins' quarry in the town of Haverstraw.

Schoharie County. In the town of Carlisle, about eight miles northwest of the court-house, the fibrous variety occurs in considerable abundance between the layers of a dark coloured slate. The mineral has a white, greyish-white, or bluish-white colour; is delicately fibrous, and often contains a large proportion of carbonate of lime. Indeed it seems to pass into the fibrous carbonate of lime by almost imperceptible gradations. The specific gravity of the purest specimens varies from 4.014 to 4.320, but even these usually effervesce slightly in acids. The veins of this mineral are from a quarter of an inch to an inch and a half in width. The fibres are parallel, and have a lustre between resinous and pearly. The mineral is sometimes translucent, and seldom perfectly opaque. It seems to undergo some change in its appearance by exposure to the atmosphere. This locality was first examined by Prof. Eaton and Lieut. Pomeroy. The first gentleman pronounced it to be heavy spar.* It seems to have been previously mistaken for celestine.

Heavy spar also occurs associated with strontianite, in the water limestone, in the vicinity of Schoharie court-house. In such cases it is generally found in the form of laminæ, which cleave readily, and sometimes present two or more faces of the primary prism. In all the specimens which I have examined, it is mixed with carbonate of lime, and also with portions of strontianite. Indeed, these two substances are so abundant in this limestone that the massive specimens of heavy spar are seldom pure.

The *Calstronbaryte* of Prof. Shepard, in my opinion, is nothing more than one of these mixed minerals. It is said to be composed of

Sulphate of baryta,	65.55
Carbonate of strontia,	22.30
Carbonate of lime,	12.15†

I might also have added another new mineral from the vicinity of Schoharie; as a specimen which I supposed to be the calstronbaryte gave upon analysis somewhat different results. But I soon ascertained that this composition was not constant, and that in this case difference in chemical composition was not to be relied on as a ground of specific distinction. As in the fibrous variety from Carlisle, scarcely any two specimens agree in this respect. Mineralogists who visit this locality, will at once see, from the manner in which the heavy spar occurs in the water limestone, from its imperfect crystallization, and from the minerals with which it is associated, the causes which influence its chemical composition, and will hence adopt with much caution the new species whose characters depend upon slight differences in the proportions of these widely diffused and constantly associated mineral substances.

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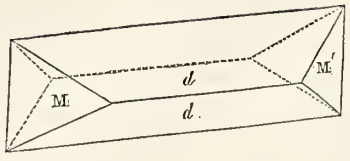
* *American Journal of Science.* II. 173.

† Shepard. *American Journal of Science.* XXXIV. 161.

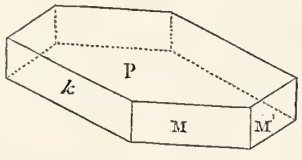
Fig. 36.



It should be stated, that minute drusy crystals of heavy spar occur in the water limestone at Schoharie. The accompanying figure 36, the *binaire* of Haüy, is introduced on the authority of Prof. Shepard. This mineral is also found in rhombic tables of a dark bluish grey colour, forming the bed of cubic crystals of iron pyrites, about a mile west of the court-house. It, moreover, occurs in laminæ running through the septaria which abound in the creek near Boyd's mill, in the town of Middleburgh. In these cases, it is usually of a bluish colour, and may easily be reduced by cleavage to the primary form.

St. Lawrence County. There are various localities of heavy spar in this county. In the town of Hammond, the crested variety occurs of a snow-white colour, and containing crystals of iron pyrites. Large crystals are found in the town of De Kalb. In the town of Fowler, tabular crystals are associated with specular iron ore. At the Parish ore bed, it accompanies calcareous spar in small geodes in the specular iron, and is found in tabular crystals having the primary form, with the acute edges replaced by two new sides, the *raccourcie* of Haüy. Fig 37. P on *k* 90° ; M on *k* 129° 13′ 54″.

Fig. 37.



This mineral also occurs in flattened crystals, variously modified, on the bank of Laidlaw lake, in the town of Rossie, where it is associated with limpid quartz, calcareous spar, and rarely fluor spar. These minerals are in a vein in the primary rock. The heavy spar is in implanted crystals, of a white or reddish-white colour, and is translucent or opaque. These crystals are sometimes two inches or more in length. The following forms have been observed at this locality :

Fig. 38.

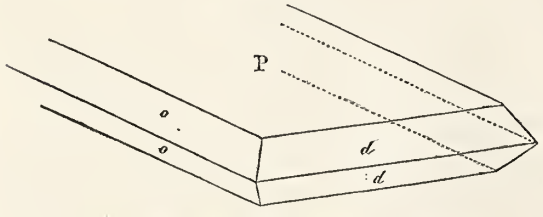


Fig. 38. The *trapézienne* of Haüy.

Fig. 39.

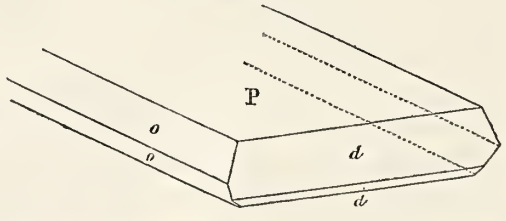


Fig. 39. The same, with one of the faces *d* much enlarged.

Fig. 40.

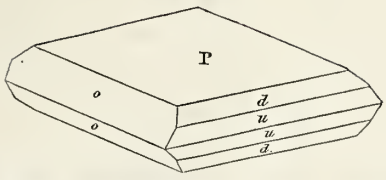


Fig. 40, *sexoctonale* of Haüy. *d* on *u* 160° 41′ 39″; *u* on *u* 116° 38′ 0″.

Fig. 41.

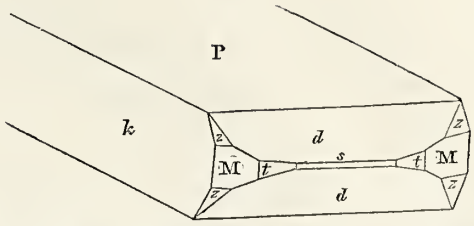


Fig. 41. M on *t* 169° 19′ 45″; *d* on *s* 129° 0′ 39″; *s* on *t* 151° 26′ 21″.

Fig. 42.

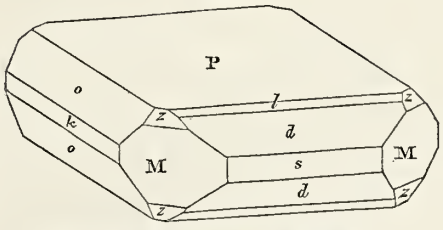
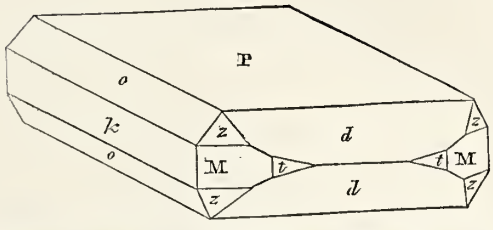


Fig. 42, *triplante* of Haüy.

Fig. 43.



Crystals similar to Fig. 43 have been found in Gouverneur.

Wayne County. Rose-red and flesh-red crystals, highly modified, although seldom perfect, occur in geodes in or near the stratum of lenticular iron ore at Wolcott.

In addition to the above localities, I may state that heavy spar is almost always found in laminæ, in those rounded masses called *Septaria*. I have already noticed its occurrence in this way in Schoharie county. It is also similarly met with near Auburn in Cayuga county, Laona in Chautauque county, and Buffalo in Erie county.

Heavy spar is of very frequent occurrence in the red sandstone near New-Brunswick and elsewhere in New-Jersey; and as it is by no means improbable that similar forms will be found in the red sandstone on the Hudson, I here insert a few of the forms which I have observed in addition to the primary (Fig. 29), which is quite common. These crystals are usually small and tabular, and have almost always a white and opaque band around their margins. They are associated with calcareous spar, and occur in veins and geodes.

Fig. 44.

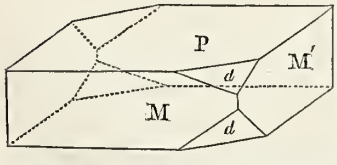


Fig. 45.

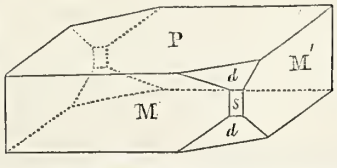


Fig. 46.

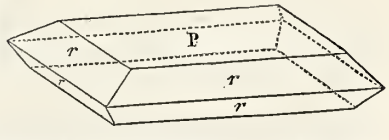


Fig. 44, *apophane* of Haüy. The obtuse solid angles replaced by single planes. Fig. 45. The same with the additional face *s*. Fig 46. P on *r* 162° 2′ 44″; *r* on *r* 35° 54′ 32″.

ORDER II. STRONTIA.

This order includes the following:

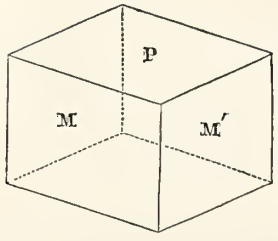
1. Celestine. 2. Strontianite. 3. Barystrontianite.

CELESTINE.

[In allusion to the sky-blue colour which it sometimes possesses.]

Strontiane Sulfatée. *Haüy.* — Sulphate of Strontian. *Cleaveland, Phillips* and *Thomson.* — Prismatoidal Baryte. *Jameson.* — Prismatoidischer Hal-Baryte. *Mohs.* — Celestine. *Beudant, Shepard* and *Dana.*

Fig. 47.



Description. Colour usually white, but sometimes blue, red or yellowish red. It occurs regularly crystallized; also massive, fibrous, radiated, stalactitic, etc. The primary form is a right rhombic prism. Fig. 47. M on M 104° (*Phillips*); 104° 48′ (*Haüy*); 104° 30′ (*Beudant.*) Cleavage perfect parallel with the sides of the primary, less so parallel with the base. Fracture uneven. Lustre vitreous, inclining to pearly. Varies from transparent to opaque. Hardness from 3.0 to 3.5. Specific gravity from 3.60 to 4.00. Before the blowpipe, it behaves very nearly like heavy spar, except that it communicates a red tinge to the flame.

Composition. Sulphuric acid 43.64, strontia 56.36 (*Beudant*). Formula $SrO.SO_3$. But it usually contains various foreign substances in small proportions.

Geological Situation. In this State, celestine is usually associated with limestone, but it does not seem to be peculiar to any geological epoch. It also accompanies gypsum, but it has not been found here in the red sandstone and trap, as it is in various parts of England.

LOCALITIES.

Cayuga County. In the rounded masses of dark coloured limestone which are found in the slate on the Owasco outlet near Auburn, thin blades of this mineral, in the form of radii, are not uncommon. It is usually white, and is associated with crystallized calcareous spar.

Herkimer County. Fibrous celestine, of a bluish grey or blue colour, and closely resembling some foreign specimens, occurs on the farm of James Crill, in the western part of the town of Stark, where it is associated with gypsum. Imperfect crystalline terminations are also found intermixed with these fibres, which have a high lustre, and are transparent. The same variety has also been observed in thin seams in the slate in a small water course near Stephen Hammond's, and not far from the old road to Fairfield. It is often mixed in various proportions with carbonate of lime.*

* Vanuxem. *New-York Geological Reports,* 1840.

Jefferson County. At Brownville, celestine is said to have been found in slender crystals; and at Chaumont bay, in masses of a snow-white colour, made up of long and slender prisms or needles, arranged in a radiated or stellated manner. Some of the specimens from this locality are nearly or quite pure. According to Dr. Emmons, this mineral occurs in the water limestone found near Depeauville.

Monroe County. Celestine has been credited to the vicinity of Rochester, where it has been said to occur in nodules in the limestone. Most of the specimens which I have examined are undoubtedly heavy spar, although it is quite probable that celestine may occur, as it is very abundant in some of the limestones farther west.

Niagara County. In the vicinity of Lockport, this mineral was first found in making excavations for the Erie canal. It has since been obtained in abundance in geodes of various sizes, often very large, associated with calcareous and pearl spar, selenite, anhydrite, etc. Two varieties occur, viz. the lamellar, and the coarsely fibrous. The lamellar variety is white and bluish white, varying from opaque to semi-transparent. It is often made up of long and slender crystals, which have the outline of the primary, or have the acute lateral edges replaced by planes which are greatly extended, forming a long six-sided prism. The specific gravity of the purest specimens varies from 3.80 to 3.95. It usually effervesces slightly in acids, from the admixture of carbonate of lime. The fibrous variety is snow-white, and almost friable. The fibres are straight, divergent or bent in various forms. It closely resembles the *Baryto-sulphate of Strontian* of Dr. Thomson, from Kingston, Upper Canada.

Schoharie County. The fibrous variety is found in thin veins, in the vicinity of the court-house. It is of a bluish colour, but is usually mixed with carbonate of lime. The lamellar variety is also said to occur at the same locality.

Fig. 48.

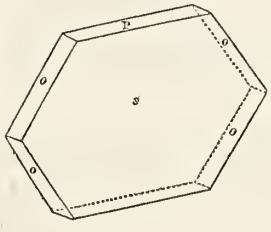
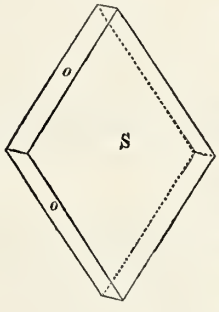
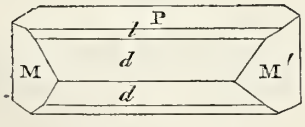


Fig. 49.



St. Lawrence County. Crystals of a delicate blue colour have been found in the Rossie lead mine, associated with the beautiful calcareous spar for which that locality is so justly celebrated. They usually have the form of low six-sided tables, resembling the *bisunitaire* of Haüy. Fig. 48. P on *s* 90° 0′; P on *o* 128° 31′; *o* on *o* 102° 58′. These crystals are somewhat convex on their broad surfaces, and are often deeply striated. Small four-sided tables, Fig. 49, are also found at this locality.

Fig. 50.



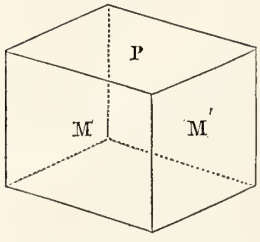
I add, on the authority of Dana, the figure (50) of a crystal from Moss, or as it is now called, Strontian island, situated at the southwestern extremity of Lake Erie, where this mineral is found in great abundance in the limestone. In colour and other characters, it closely resembles one of the varieties found at Lockport. P on *l* 157° 47′; *d* on *d* 78° 28′; *d* on *l* 162° 69′ (*Haüy*).

STRONTIANITE.

[From *Strontian* in Scotland, where it was first found.]

Strontiane Carbonatée. *Haüy.* — Carbonate of Strontian. *Cleaveland.* — Strontites. *Phillips.* — Green Carbonate of Strontian. *Thomson?* — Peritomous Baryte. *Jameson.* — Peritomer Hal-Baryt. *Mohs.* — Strontianite. *Beudant, Shepard* and *Dana.*

Fig. 51.



Description. Colour asparagus green, yellowish brown, yellowish, grey and white. Occurs regularly crystallized; also massive, fibrous and stellated. The primary form is a right rhombic prism. Fig. 51. M on M′ 117° 32′. Cleavage parallel with M, rather perfect. Fracture in other directions uneven. Lustre shining, glistening and pearly. More or less translucent. Brittle, and easily frangible. Hardness 3.5. Specific gravity from 3.60 to 3.80. Before the blowpipe, it does not fuse, but is converted on the surface into an enamel, which assumes a dazzling whiteness, and gives the flame a reddish hue. With borax, or biphosphate of soda, it fuses into a clear glass. It is soluble with effervescence in nitric or muriatic acid; and papers dipped into this solution, when dried, burn with a red flame.

Witherite or carbonate of barytes, which this mineral often closely resembles, has a higher specific gravity, and melts before the blowpipe without changing the colour of the flame.

Composition. When pure, this mineral is composed of carbonic acid 30, and strontia 70. Its formula is $SrO.CO_2$. But as it occurs in nature, it usually contains small quantities of lime, baryta, manganese, water, etc.

Geological Situation. It occurs in veins of calcareous spar and galena, and in the hydraulic limestone.

Uses. This mineral is used in the preparation of the other salts of strontia.

LOCALITIES.

Jefferson County. Strontianite has been found in radiated masses on Muscolunge lake, where it forms part of the matrix of fluor spar. It has a white and pale green colour, and is fibrous. It is also said to occur at Chaumont bay, in this county.

Schoharie County. It occurs in geodes and nests, sometimes of large size, in the hydraulic limestone. The most remarkable locality is in the face of the hill about two miles from the court-house. This variety has a snow-white colour, is compact, and susceptible of a good polish. It was formerly mistaken for common white marble, its true nature having been first pointed out by Dr. Emmons.* The specimens which I have examined are nearly pure

* *American Journal of Science,* XXVII. 182.

carbonate of strontia, containing only a very small admixture of carbonate of lime and oxide of iron. In the vicinity of the court-house, strontianite also occurs in fibrous masses, implanted upon a dark blue calcareous spar. Some of these fibres are nearly two inches in length, and resemble certain varieties of arragonite.

Fig. 52.

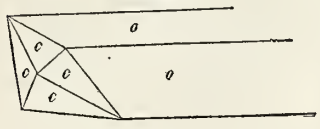


Fig. 53.

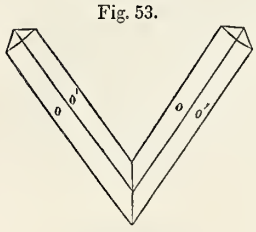
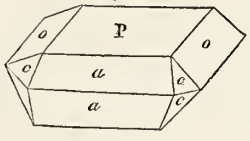


Fig. 54.



Various crystalline forms have also been noticed at this locality. Of these, Fig. 52, Fig. 53, and Fig. 54, are introduced from Prof. Shepard's paper on the Strontianite of Schoharie.* P on *a* 120° 0′; *a* on *a* 120° 0′; *o* on *o* 160°.

Fig. 53 represents a compound form, commonly called a V crystal. "The face of composition is apparently parallel with the vertical edges between *c* and *c* (Fig. 52). The individuals project beyond the face of composition only on one side; but the composition is often represented in parallel laminæ."

"Another form is represented by Fig. 54, though the planes *c c* are rarely very distinct. They are an inch in length (in the direction of the edge between *a* and *a*), and nearly half an inch in thickness. Colour bluish or reddish grey; translucent. The surface P is streaked parallel with its edge of combination with *o*."

The *Emmonsite* of Dr. Thomson, is certainly nothing more than a mechanical mixture of carbonate of strontian and carbonate of lime. The composition is stated to be as follows:

Carbonate of strontia,	82.69
Carbonate of lime,	12.50
Peroxide of iron,	1.00
Zeolite,	3.79†

The remarks made in regard to the mixtures of sulphate of barytes and carbonate of lime (page 207), are equally applicable in this case. The chemical composition alone cannot be relied on as a ground of specific distinction.

BARYSTRONTIANITE.

[From its containing both *baryta* and *strontia*.]

Barystrontianite. *Cleaveland* and *Phillips*. — Stromnite. *Thomson* and *Shepard*. — Appendix to Strontianite. *Beudant*. — Baryto-Carbonate of Strontia.

Description. Colour greyish white, passing into yellowish white. It occurs massive, radiated, or composed of small plates or radii somewhat diverging. Lustre shining, inclining

* *American Journal of Science*, XXVII. 363. † Ib. XXXI. 171.

to pearly. In thin plates, translucent. Brittle, and easily frangible. Hardness 3.5. Specific gravity from 3.70 to 3.90. Infusible before the blowpipe. Partly soluble, with effervesence, in nitric and muriatic acids.

Composition. *Specimen from Stromness, in one of the Orkney islands.* Carbonate of strontia 68.60, sulphate of baryta 27.50, carbonate of lime 2.60, oxide of iron 0.10 (*Trail*).

Although I have introduced the above description of this mineral, it is by no means certain that it is entitled to the rank of a distinct species. The only fact in favour of the latter view is, that according to the above analysis, the carbonate of strontia is in the ratio of four atoms to one atom of sulphate of baryta. This, however, may be accidental.

LOCALITIES.

Oneida County. A mineral was many years since found near Hamilton College, which agrees very well with the above description; and Dr. Emmons supposes the same mineral to occur in Schoharie county.

ORDER III. LIME.

This order embraces the following species:

1. Carbonate of Lime.
2. Arragonite.
3. Gypsum.
4. Anhydrite.
5. Apatite.
6. Fluor Spar.
7. Muriate of Lime.
8. Datholite.
9. Pharmacolite.

CARBONATE OF LIME.

A mineral yielding caustic or quicklime by calcination; soluble with effervescence in dilute nitric or muriatic acids: the solution affording an abundant precipitate with oxalate of ammonia.

There are several important sub-species or varieties, which it will be convenient and proper to notice separately.

CALCAREOUS SPAR.

Chaux Carbonatée. *Haüy.* — Calcareous Spar. *Cleaveland* and *Phillips.* — Calcareous Spar, or Rhombohedral Limestone. *Jameson.* — Rhomboedriches Kalk-Haloid. *Mohs.* — Calcaire. *Beudant.* — (Thomson, Shepard, and Dana include all the varieties of carbonate of lime under the name of Calcareous Spar. I restrict the latter term to the regularly crystallized forms of carbonate of lime, and to those imperfect crystals or masses, which, by cleavage, yield the primary rhombohedron.)

Description. Colour, of pure varieties, white; when impure, it is often tinged with various shades of yellow, grey, red, green, brown, and even black. Streak white and greyish white. It occurs frequently crystallized, and, of all known minerals, exhibits the greatest number of varieties of the rhombohedral series of crystallization. The primary form is a rhombohedron, having angles of 105° 5′ and 74° 55′ (Fig. 55). When transparent, it is doubly refractive, and is then often known by the name of *Iceland Spar*. The various secondary forms can easily be reduced to the primary, as shown in Fig. 56 and 57. Lustre, when pure, splendent and vitreous. Hardness 3.0; scratches gypsum, but is scratched by arragonite. Specific gravity from 2.50 to 2.80. Before the blowpipe, alone, it becomes caustic lime, and shines with peculiar brightness as soon as all the carbonic acid is driven off; with borax or biphosphate of soda, it fuses with effervescence into a glass.

Fig. 55.

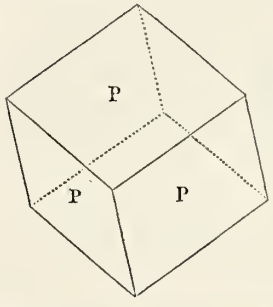


Fig. 56.

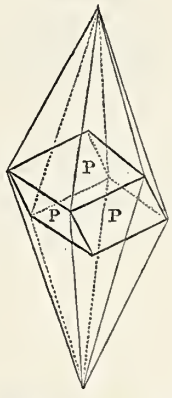
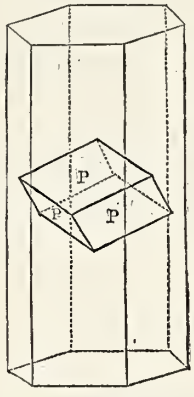


Fig. 57.



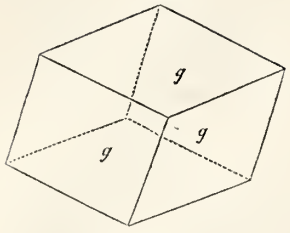
Calcareous spar, as well as all the other subspecies under carbonate of lime, may be distinguished from gypsum by its greater hardness, and by its effervescence in dilute acids. It is not so hard as fluor spar, and it does not, when its powder is thrown into warm sulphuric acid, yield a gas capable of corroding glass. It possesses a less specific gravity than the carbonates of barytes, strontian or lead, each of which it sometimes resembles.

Composition. *Specimen from Iceland*—carbonic acid 43.70, lime 56.15 (*Stromeyer*); carbonic acid 43.05, lime 56.33 (*Biot*). Formula $CaO.CO_2$.

Geological Situation. Calcareous spar does not appear to be peculiar to any class of rocks. It is found in veins in the granite and gneiss both of northern and southern New-York, while it also abounds in almost all the limestones and slates in the central and western portions of the State.

LOCALITIES.

Fig. 58.



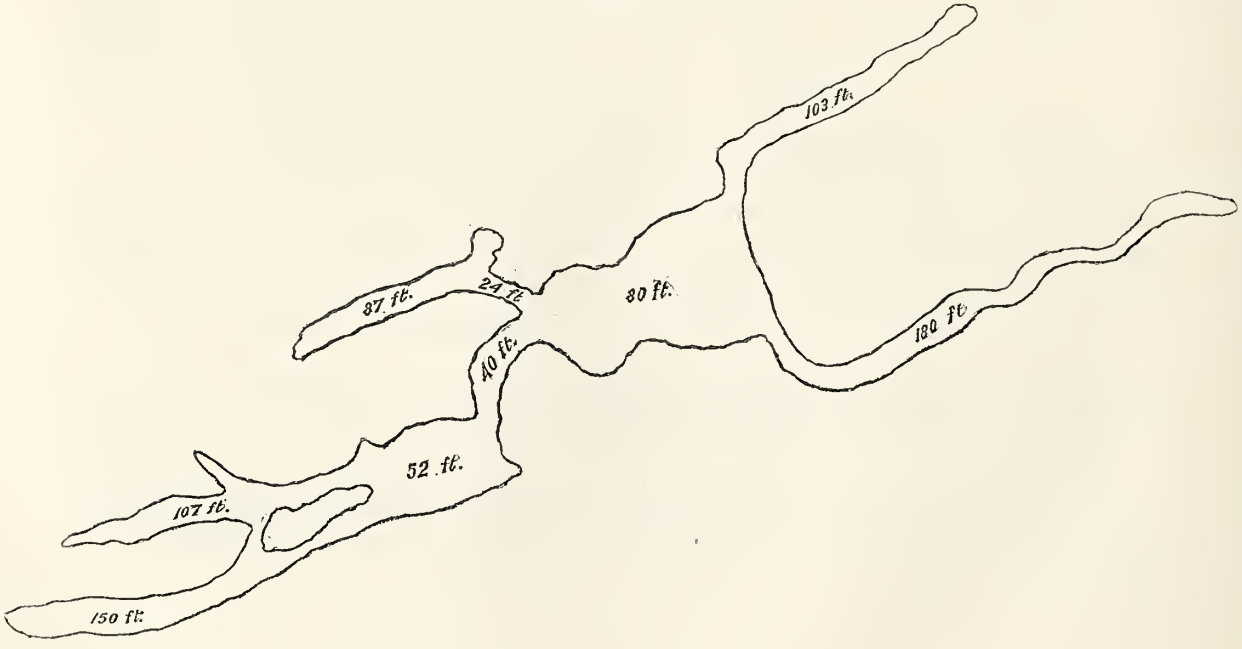
Albany County. In the town of Bethlehem, calcareous spar, associated with crystallized quartz, occurs in the seams of greywacke on the banks of the Norman's kill, two miles south of Albany. The crystals are the *equiaxe* of Haüy, with the edges usually rounded, giving them a form somewhat *lenticular*, a name by which they are often known. Figure 58, g on g 134° 26′.

In a cavern about twelve miles south of Albany, large masses are found of a white and brownish colour, which, although they do not exhibit regular crystalline forms, are easily cleavable into rhombohedrons. Other varieties of carbonate of lime are found in this cavern, as stalactites, stalagmites, etc.

In the same town there occur, in the water limestone, cavities which are studded with small rhombohedral crystals of calcareous spar. The angles of the crystals are usually rounded as if by fusion, similar to those found in the county of Schoharie, to be hereafter described. There are also dodecahedrons, and dodecahedrons terminated by three rhomboidal faces; but these crystals are quite small.

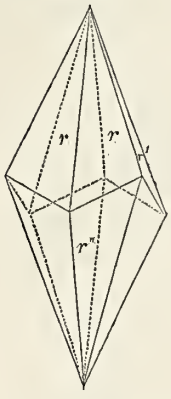
In the town of Knox, twelve miles northeast of Schoharie court-house, there is a cavern about five hundred feet in length, a ground plan of which is given in the annexed cut (Fig. 59).

Fig. 59.



This cavern contains masses of calcareous spar, in the forms which are usual in such localities. The specimens, however, are seldom so beautiful as those which are found in the caverns of the county of Schoharie.

Fig. 60.



Cayuga County. In the slate near the village of Auburn, there are often found rounded masses of a dark coloured limestone, called *Septaria*. These are crossed in various directions by veins of celestine, among which minute crystals of calcareous spar are also observed. They usually have the form of the scalene dodecahedron, *métastatique* of Haüy. Fig. 60. r on r 144° 20′ 26″; r on r' 104° 28′ 40″; r on r'' 133° 26′ 0″. These crystals deserve to be particularly noticed, in consequence of their association with celestine.

Clinton County. According to Dr. Emmons, crystallized carbonate of lime occurs at the Finch ore bed.

Dutchess County. Dark colored calcareous spar is found in the town of Rhinebeck, in this county.

Fig. 61.

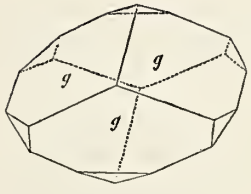
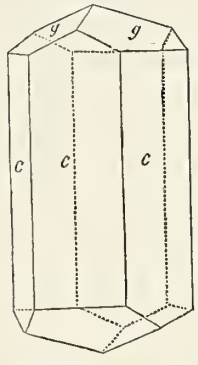


Fig. 62.



Essex County. In the town of Moriah, on Mill brook, near Port Henry, crystals of calcareous spar are found in veins in white limestone. The forms which I have observed at this locality are similar to Fig. 58, and to those here introduced. Fig. 61 is the *équiaxe*, with the lateral angles replaced by planes. In Fig. 62, the replacing planes are still further extended, forming the *dodécaèdre* of Haüy. c on c 120° 0′.

In the town of Schroon there are translucent masses having a fine green tinge, from which cleavages of great beauty may be obtained. When held between the eye and the light, they bear a great resemblance to pearl, especially if of considerable size. They sometimes contain small scales of graphite.

In Ticonderoga, at Rogers' rock, there are often found masses made up of minute crystals of calcareous spar of the primary form, with grains of yellow garnet, and small but highly finished crystals of feldspar or albite. The whole are very feebly aggregated, and may be easily crumbled by the fingers. According to Cleaveland, hemitrope or grouped crystals of calcareous spar occur at this locality, but I have not been so fortunate as to meet with any specimens.

Greene County. Large but imperfect crystals are found in veins in the limestone on the Catskill and Canajoharie railroad, about two miles from the village of Catskill, from which, however, fine cleavages can be obtained. They are sometimes transparent, but are usually opaque and white. Near this locality there are smaller but more perfect crystals, having the form of the *équiaxe* of Haüy (Fig. 58), and also the modifications, Fig. 63 and Fig. 64.

Fig. 63.

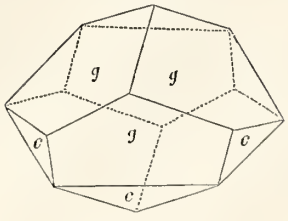


Fig. 64.

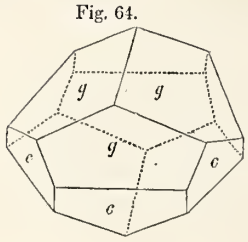
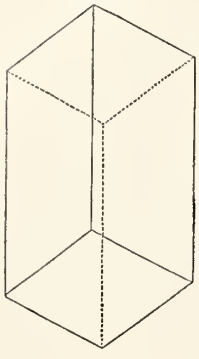


Fig. 65.



Small crystals having the primary form are found associated with crystallized quartz in fissures in the slate, at Diamond hill, near the village of Catskill. They sometimes have their edges and angles rounded, similar to those which are observed in Albany and Schoharie counties. The crystals not unfrequently assume the form of an oblique rhombic prism, which is twice as long as it is broad (Fig. 65). Minute crystals of the form represented in Fig. 63, also occur. The prisms of quartz intermixed with the calcareous spar at this locality are often long and slender, and have their points coated with carbonate of lime.

Hamilton County. According to Dr. Emmons, blue calcareous spar occurs on Long lake, in this county. I have met with a similar variety in Lewis county, which I shall notice in its proper place.

Herkimer County. There is a fine locality of calcareous spar about a mile south of Little-Falls. In the bed of a small stream, and in the blue limestone which rests upon the calciferous sandrock, there is a vein of some width, which is entirely made up of the crystallized spar. The crystals are white, and their usual forms are the *équiaxe* of Haüy (Fig. 58), and the modification (Fig. 63). They are sometimes from two to three inches in diameter.

At Middleville, low six-sided crystals, similar to that represented in Fig. 64, and sometimes of very large size, are found in the cavities of calcareous sandrock, associated with anthracite, and the beautiful crystals of limpid quartz for which this locality is so justly celebrated.

Jefferson County. This and the adjoining county, St. Lawrence, contain numerous localities of calcareous spar, which are of great interest. Indeed, there is probably no part of the world in which the crystalline forms of this mineral exhibit greater variety or beauty, or where crystals of such enormous size have been found.

By far the most interesting locality in this county, is that on the lands of Dr. Benton, near the village of Oxbow. Large crystals have here been found in the soil, or rather in a decomposed limestone, which by cleavage often furnish beautiful rhombohedrons nearly transparent and colourless, or with a delicate tint of rose or purple, and which possess the property of double refraction. Sometimes they are white and opaque; at others, they have a brownish colour, and have their cleavage planes bent like the crystals of pearl spar; but this variety constantly

passes into the white, opaque or transparent ones. The exterior of these crystals is always more or less rough, but they are often translucent throughout, in which case the peculiar tint can be distinctly seen. They are sometimes a foot or more in length, and some have been found weighing nearly one hundred pounds. A striking peculiarity of many of the crystals is, that three sides of the rhombohedron are perfect, while the others are drawn out into the form of the *hog-tooth spar*, the summit having a kind of cap of a different colour from the body of the crystal, and having the appearance of a subsequent deposit. They are indeed sections of dodecahedrons built upon the primitive rhombohedron, but which either the position of the crystal, or some other cause, has prevented the completion of, on the opposite side. I have endeavored to represent them in Figures 66 and 67. P on *r* 151° 3′.

Fig. 66.

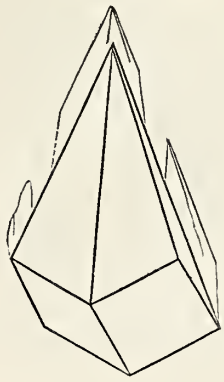
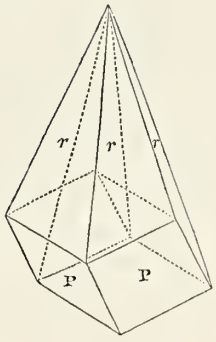


Fig. 67.



Four miles south of Oxbow, in the town of Antwerp, and on the road to that village, an excavation for lead ore as usual opened a fine vein of calcareous spar. Large masses and imperfect crystals were found, from which beautiful cleavage crystals have been obtained. They are white, purple and brownish, as at the preceding locality. They usually have a lustre which is more highly vitreous than it is in any specimens of this kind which I have seen.

Fig. 68.

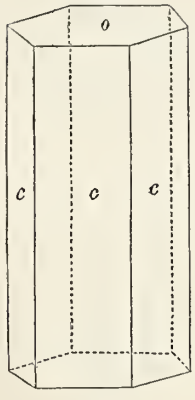
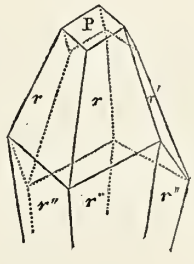


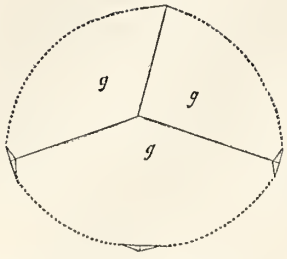
Fig. 69.



At this locality, there have also been found crystals in the form of six-sided prisms, *prismatique* of Haüy (Fig. 68); and in that of the scalene dodecahedron terminated by three rhomboidal faces, *binaire* of Haüy (Fig. 69). *c* on *o* 90° 0′; *c* on *c* 120° 0′. P on *r* 151° 3′; *r* on *r* 144° 20′ 26″; *r* on *r*′ 104° 28′ 40″; *r* on *r*″ 133° 26′.

On the east bank of Vrooman lake, a mile northwest of the village of Oxbow, calcareous spar is found in abundance in veins in the primary rock, associated with crystallized quartz. The forms are the *binaire* of Haüy (Fig. 69), and the rhombohedron with two or more of the edges replaced by new planes. Numerous crystals are usually grouped together, in such a manner as to exhibit a very complicated arrangement. This is a locality well worthy the notice of the mineralogist.

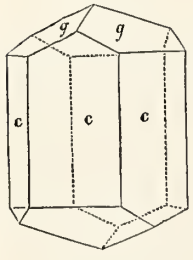
Fig. 70.



At Brownville, four miles from Watertown, perfect crystals have been found in the form of the *équiaxe* of Haüy (Fig. 58); and the same with the edges rounded, forming *lenticular* crystals (Fig. 70).

There remains still to be noticed a locality in the town of Wilna, about a mile northeast of Natural bridge. Crystals of calcareous spar are found in seams in the primary limestone. They are white, and exhibit a variety of forms, as the low six-sided prism, elongated dodecahedrons, and rhombohedrons with various truncation. They are, however, seldom sufficiently perfect for accurate measurement. In the same vicinity, there are large masses of this mineral so loosely aggregated that a blow of a hammer causes them to separate into rhombohedrons of various sizes. The smaller specimens are translucent, and have a delicate and beautiful blue tint. This colour is probably owing to oxide of iron; but if so, the quantity is too small to be easily detected by analysis.

Fig. 71.



Lewis County. This county abounds in localities of calcareous spar, which afford a variety of interesting forms. It occurs in the Trenton limestone, and is often associated with galena, iron pyrites and fluor spar. The most common form is the *dodécaèdre* of Haüy (Fig. 62), which occurs at Leyden, Lowville and Martinsburgh. The prism, however, is often much compressed, as in the accompanying Fig. 71. At Lowville, the calcareous spar is associated with iron pyrites and cubical crystals of fluor spar, in a vein on the banks of the creek near the falls.

At Martinsburgh, the best crystals were obtained from the excavations that were made for lead ore, with which they are here often associated. In addition to the lenticular crystals which occur at this locality, are several modifications of the *dodécaèdre*, some of which are represented in Figs. 72, 73, 74 and 75:

Fig. 72.

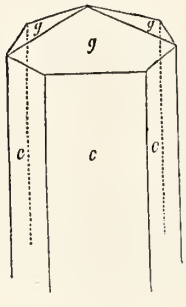


Fig. 73.

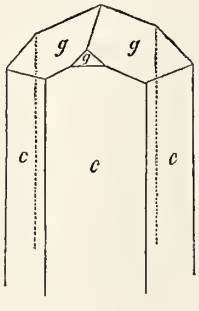


Fig. 74.

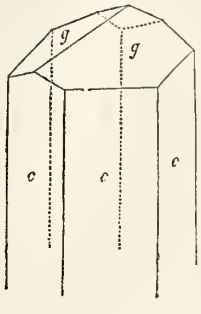


Fig. 75.

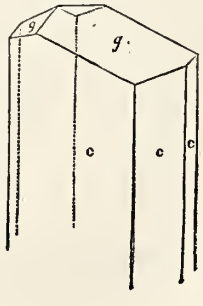
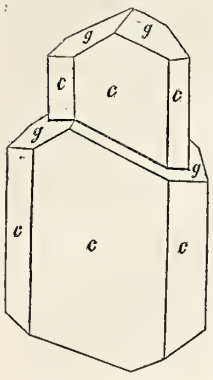


Fig. 76.



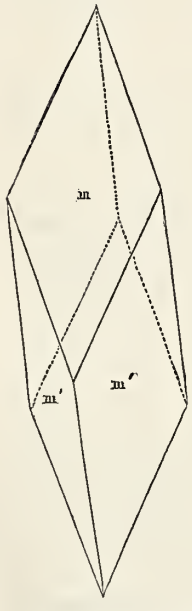
These crystals have usually only one perfect termination, but this, as well as the sides, is highly finished. They are white, translucent or transparent. Twins, or compound crystals of the form represented in Fig. 76, are occasionally met with at Martinsburgh.

Crystals similar to some of the above have also been found at Houseville and Leyden in this county, and it is probable that most of the modifications which I have noticed will hereafter be detected.

Monroe County. Crystals of calcareous spar, having the form of the *métastatique* of Haüy, occur in geodes in the limestone at Rochester and elsewhere. The specimens, however, are far inferior in beauty to those found in Niagara county, which see.

Montgomery County. There is an unimportant locality of this mineral at the lead mine two miles south of Spraker's basin, on Flat creek. The crystals are sometimes of the *hog-tooth* form, but they are small and imperfect. Calcareous spar is also found at Flint hill, and it is credited to the town of Florida. The limestone every where contains seams of white calcareous spar, but so far as my observation extends, it rarely exhibits perfect crystalline forms.

Fig. 77.



Niagara County. For the beauty and abundance of crystallized calcareous spar, there is no district in this country which can be compared to that in the vicinity of Lockport. The excavations which have been made for the Erie canal, through the geodiferous limerock, have brought to light geodes of almost all sizes and forms, containing calcareous spar, pearl spar, celestine, selenite, anhydrite, and rarely fluor spar, variously associated and grouped. The individual crystals, however, are usually small; and it is somewhat singular, that while this mineral is so extremely abundant, there is so little variety in the crystalline forms. The only ones that I have observed are the scalene dodecahedron, *métastatique* of Haüy (Fig. 60); and the acute rhombohedron, *contrastante* of Haüy (Fig. 77), m on m′ 114° 19′; m′ on m′ 65° 41′.

In many cases the six additional edges making up the dodecahedron are scarcely visible, the faces of the rhombohedron being merely slightly rounded. I have seen a few crystals of the *binaire* of Haüy (Fig. 69).

The colour of the crystals of calcareous spar found at Lockport is either white or yellowish white, and they are translucent or transparent. They are rarely more than an inch and a half in length.

At Niagara falls, and at Lewiston, geodes of calcareous spar have been found similar to those of Lockport, but of far inferior beauty. At the falls, this mineral is sometimes associated with yellowish crystals of fluor spar, which may have perhaps been mistaken for the

cubic calcareous spar credited to this region. Six-sided prisms of calcareous spar are also said to have been found at the foot of Goat island.*

Oneida County. On the western bank of Dry Sugar river, near Boonville, there occur crystals of calcareous spar, having the forms represented in Figs. 62 and 63. The rock in which they are found is very hard, and divisible into layers of from two to twelve inches in width; it requires much labour and care to extract the specimens without injury. These crystals are contained in veins which are filled with wet argillaceous earth. They are sometimes an inch in length.†

Onondaga County. On the track of the Auburn and Syracuse railroad, near the village of Camillus, the *hog-tooth* variety is found in considerable abundance. It is usually of a yellowish colour, and the crystals are seldom more than half an inch in length. It is associated with fibrous carbonate of lime, or what has been called *arragonite.*

Orange County. There are several localities of calcareous spar in this county, but they seldom afford well defined crystalline forms. A white variety, from which fine rhombohedrons may be obtained by cleavage, is found at the O'Neil mine, in the town of Monroe. About a mile southwest of Amity, it is white and nearly transparent; and in the vicinity of the same place, specimens are found which are singularly variegated. At several localities it is of a beautiful flesh-red colour, as at Amity, at Two ponds in Monroe, at the Queensborough mine, and in various parts of the town of Cornwall. This variety, which I have not met with out of this county, usually has associated with it small crystals or grains of scapolite and coccolite. It is richly worth a place in every cabinet.

Veins of white calcareous spar occur in the slate at Newburgh, and to this may be added two other localities, viz. the one, two miles east of the Greenwood furnace; and the other, four miles southeast of Woodbury furnace.

Putnam County. At the Denny mine in Phillipstown, small crystals having the primary form are found on the magnetic iron ore. Masses are also found, exhibting the rhombic cleavage, at Hustis' farm in the same town, and at Coldspring. But the most interesting locality in this county is that which was made known to me by Mr. Cyrus P. Fountain. It is near the village of Patterson, where loose crystals are found adhering to the fibres of asbestus which is common in the dolomitic limestone. These crystals are white or yellowish, and have both terminations perfect, although they are usually small, seldom exceeding half an inch in length. The most common forms are the scalene dodecahedron, modified as in Fig. 78; and a twin crystal, Fig. 79.

Fig. 78.

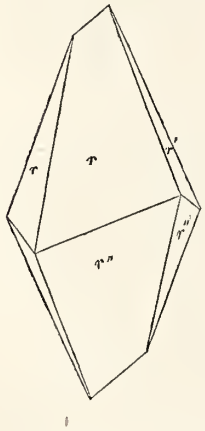
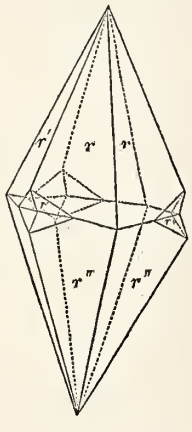


Fig. 79.

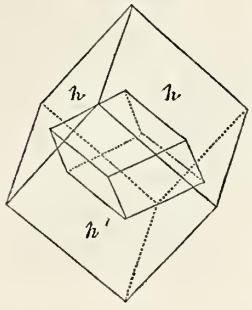


* *Cleaveland's Mineralogy.*

† Prof. O. P. Hubbard. *American Journal of Science,* XXXII. 230.

Rensselaer County. Crystals assuming the lenticular form, but of small size, have been found in fissures in the rock, near Troy.

Fig. 80.



Rockland County. The excavations for the New-York and Erie railroad at Piermont, have exposed veins of trappean minerals of several kinds. Associated with these are found minute crystals of calcareous spar, which sometimes have the form of the scalene dodecahedron; and at others, nearly approach the cube, *cuboïde* of Haüy. Fig. 80. *h* on *h* 87° 48′; *h* on *h*′ 92° 12′. In my specimens, these crystals are associated with stilbite.

At Tompkins' limestone quarry near Caldwell, several very interesting forms of calcareous spar have recently been found. Indeed this promises to become one of our most important localities. The crystals are often doubly terminated, and vary in size from being minute, to two or three inches in length. They are often highly finished and perfect; most commonly, however, they are grouped, and exhibit only a single termination. The colours are white and yellowish; translucent to opaque. The forms which I have observed are the

Fig. 83.

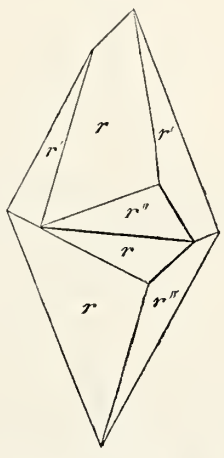


Fig. 81.

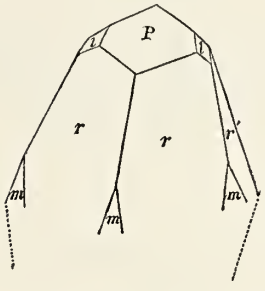
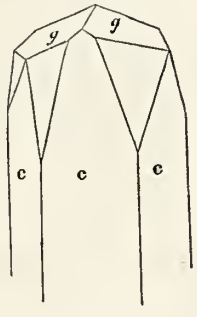


Fig. 82.



binaire of Haüy (Fig. 69); the modification, Fig. 81; the *dodécaèdre* of Haüy (Fig. 62); the same with the edges replaced at the upper part by triangular planes, Fig. 82; the *métastatique* of Haüy (Fig. 60), and a modification similar to Fig. 78; together with a twin of the same, Fig. 83. The terminal planes of Figs. 62 and 82 often have a convex form, which extends also to the sides of the prisms; it is hence very difficult to determine the exact value of the replacing planes.

To the above may be added the following, which have also been found at this locality:

Fig. 84. Fig. 85. Fig. 86. Fig. 87.

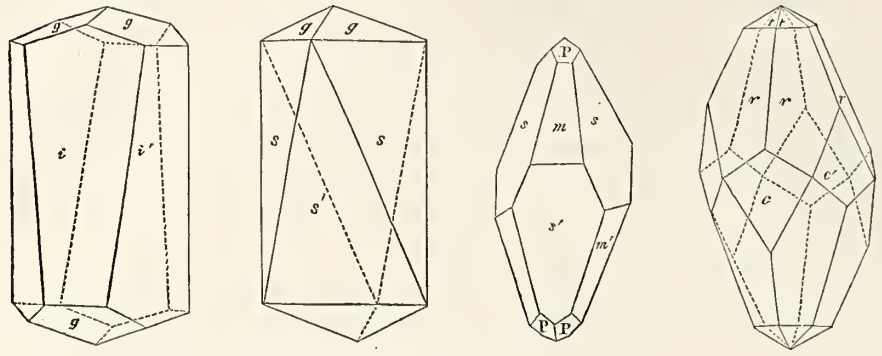


Fig. 84, the *contractée* of Haüy. g on i 112° 10′.

Fig. 85, *unimixté* of Haüy. g on s 127° 52′ 30″; s on s' 116° 15′ 5″.

Fig. 86, *trirhomboidale* of Haüy. P on m 149° 2′ 11″; P on s 119° 2′ 11″; m on s' or m' on s 154° 39′ 13″; m on s or m' on s' 121° 32′ 54″.

Fig. 87, *soustractive* of Haüy. t on t 137° 39′ 26″; c on r or c' on r 152° 6′ 52″.

Fig. 88. Fig. 89. Fig. 90.

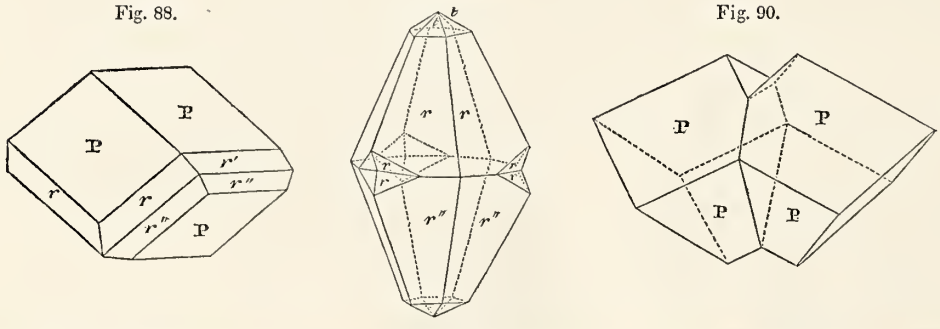


Fig. 88. The primary rhombohedron, with the lateral edges replaced by two planes. P on r or r' 151° 2′ 40″.

Also the twin crystals, Figs. 89 and 90.

St. Lawrence County. Probably no part of the world has furnished more beautiful or interesting forms of calcareous spar, than the county just named. This will sufficiently appear when I state that crystals have been obtained from nine to twelve inches in diameter, with all the sides and angles perfectly finished. The usual colours of these crystals are white or straw-yellow; they vary from transparent to opaque. They occasionally contain water or some other liquid, but it soon disappears, as the specimens are very liable to be cracked or broken by exposure to alternations of temperature. Mineralogists are indebted for the fine crystalline forms of calcareous spar for which this county is so celebrated, to the mining operations, which were commenced here in 1836, and actively prosecuted during the two

succeeding years. It was observed that galena almost always occurred in veins of this spar; and as these veins were very abundant, they were frequently opened at considerable expense, when there was not the least appearance of ore to warrant the outlay. It will be unnecessary for me therefore to notice in detail all the localities of calcareous spar in this county, as it occurs in some form or other at all the so called lead "diggings."

The finest crystals have heretofore been found at the Rossie lead mine. Their forms are exceedingly various, and require particular descriptions. Crystals of a delicate straw-yellow colour, almost perfectly transparent, and from eight to ten inches in diameter, have occasionally been found in this vein; while smaller ones, variously aggregated, have been obtained from it in vast quantities. They occur in the water-filled cavities of the mine, and are associated with crystallized galena, iron and copper pyrites, and rarely crystallized celestine.

In addition to the primary form, which is common, we have here the primary with two of the solid angles replaced by tangent planes. Fig. 91, P on *c* 135° 0′. These planes are

Fig. 91.

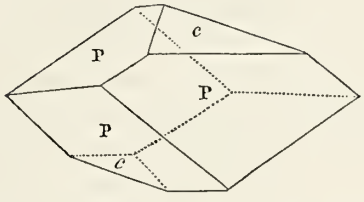


Fig. 92.

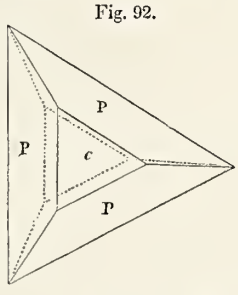
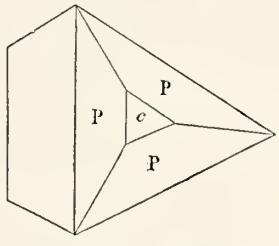


Fig. 93.



variously extended. Twins, as I suppose, of the above form, are also found. The face of composition is at right angles to the vertical axis, and the crystal has a triangular outline, Fig. 92. In other cases the face of composition projects, as in Fig. 93. Another twin, which is common here, is that which is represented in Fig. 94. All these forms are variously modified. The distorted scalene dodecahedron, Fig. 95, credited to Rossie, is from Dana's Mineralogy.

Fig. 95.

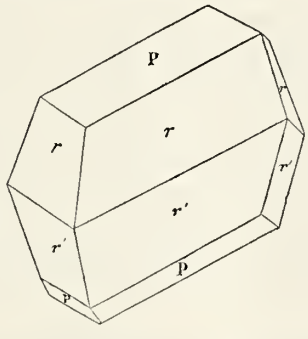
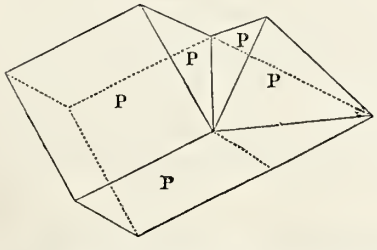


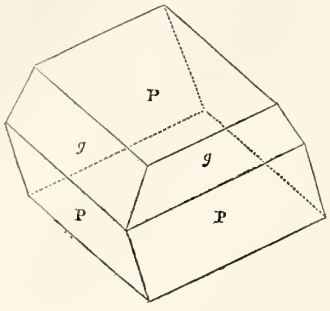
Fig. 94.



It is proper to state, that the crystals from which several of the above figures were drawn, were obligingly loaned to me by Dr. Emmons, whose collection of minerals from this county is unrivalled for extent and beauty.

Near De Long's mill two miles from the Rossie mine, at the Jepson vein in Rossie, at the Wilson vein in Gouverneur, and at Mineral point on Black lake, specimens have been found similar to those already described, but they seldom exhibit such a variety of forms.

Fig. 96.



At the Natural dam, about two miles from the village of Gouverneur, loose crystals of various sizes occur in a decomposed rock. Some of these are very large, but they are usually from half an inch to two inches in length. Many of them are single rhombohedrons with the contiguous acute edges replaced by broad tangent planes. Fig. 96. P on *g* about 143°. In some cases, three or four of the sides are similarly replaced. Two, three or more crystals are often grouped together by the opposite faces, presenting an imbricated appearance. Figs. 97 and 98 represent twin crystals which I have found at this locality, and the arrangement of which will be easily understood. It may be observed that the colour of the calcareous from the Natural dam is often brown, and the surfaces of cleavage are bent like pearl spar. But here as at Oxbow in Jefferson, this variety constantly passes into the white, transparent and opaque kinds. They are probably all pure, or nearly pure carbonate of lime.

Fig. 97.

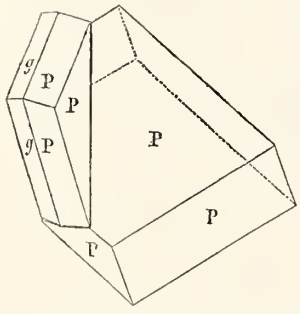
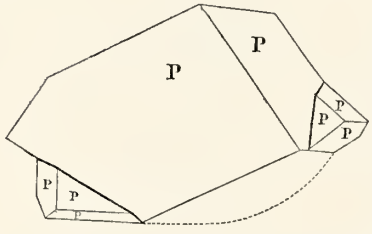
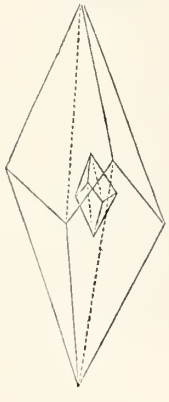


Fig. 98.



In the town of Rossie, about a mile southeast of Oxbow in Jefferson county, there is a locality not unlike that on the farm of Dr. Benton (see page 218). The crystals are similar in form, and are also found in a decomposed limestone. Transparent cleavages of considerable beauty have been obtained here, as well as those which are white and opaque, brown, yellow, rose and purple. Crystals of three or four inches in length occur, which are doubly terminated. Many of them are peculiar in having a white opaque coating on the surface, and some of them appear to have undergone a kind of dissection or solution, the whole exterior being studded with sections of minute crystals. The appearance is not unlike that which is observed when an amorphous mass of alum is allowed to remain for some time in water. The most interesting crystalline form that I have observed here, is a compound one represented in Fig. 99. As in some of the crystals from Lockport, six of the edges are not well defined, the principal faces being only a little rounded.

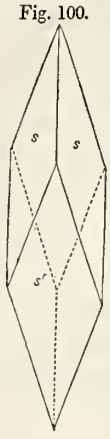
Fig 99.



At the Parish ore bed in Gouverneur, geodes of calcareous spar are found in the specular iron ore; some of which possess considerable beauty. The forms are the primary and the *dodécaèdre* of Haüy (Fig. 71).

To the above localities, I may add the bank of Laidlaw lake, Rossie, where loose crystals have been found; and the town of Russel, where it is said to be of a reddish colour.

Fig. 100.



Schenectady County. About two miles north of the city, on the banks of the Mohawk, there is a stratum of gravel cemented by calcareous spar, which has the form of an acute rhombohedron, the *mixté* of Haüy. Fig. 100. *s* on *s* 63° 44′ 55″; *s* on *s′* 116° 15′ 5″. The faces, however, are sometimes a little rounded, and there is an approach to the *métastatique* of Haüy; but this form is never well developed. This mineral has been called *arragonite;* in my opinion, incorrectly.

Schoharie County. Interesting localities of calcareous spar occur in various parts of this county. It has long been noted for the number of caverns which it contains. These, as usual, abound in several varieties of carbonate of lime, but they seldom furnish well defined or curious crystalline forms. There are, however, several localities in various parts of the county, where crystals of calcareous spar are found. These are generally in veins in the limestone, or argillaceous limestone, which is here so abundant. Near Middleburgh, they are in the form of the primary, with masses of anthracite occasionally running through them. About a mile and a half east of the court-house, there is a vein ten or twelve inches in width, where have been obtained crystals similar to Figs. 63 and 70, and nearly an inch in diameter; and there are several veins in the vicinity, where obtuse rhombohedrons occur.

But the most interesting specimens of this mineral are those found on the banks of a small stream which empties into the Cobleskill, four miles west of Schoharie court-house. At this place there are, in a kind of water limestone, geodes of various sizes, sometimes a foot in diameter, lined with crystals of calcareous spar, often forming specimens of great beauty. The crystals are usually rhombohedrons, with the edges and angles truncated, and often rounded in the manner already noticed under the head of Albany county, where similar specimens occur in the water limestone of the Helderberg. They are also sometimes in the form of the *métastatique* of Haüy; and with all these, are intermixed delicate crystals of strontianite of a white or yellowish white colour. Occasionally there occur at this locality twin crystals of calcareous spar of a small size, some of which resemble those at Haverstraw in Rockland county (Fig. 90), being formed from the union of two rhombohedra; while there is another, which is in the form of the double rhombic prism.

The specimens of the calcareous spar from the various caverns, with which this county abounds, should also be here noticed; for although these do not often occur in regularly crystallized forms, they can in most cases be easily reduced to the primary by cleavage. Of these the most extensive is *Ball's Cave*, situated about four and a half miles northwest of Schoharie court-house. This was first explored in September, 1831, by John Gebhard, Esq. and other gentlemen. This cavern abounds in stalactites and stalagmites of great size and beauty, with occasional crystals of the calcareous spar. The specimens are sometimes of snowy whiteness, and often of a highly crystalline texture, although regular forms cannot be observed.

The greatest length of this cavern, as far as it has been explored, is about two-thirds of a mile. It contains fourteen rooms, ten of which branch off laterally from the main course of the cavern; and two lakes or pools, the surface of the one in the northern passage being ten feet above the level of the other, and both containing water varying in depth from two to thirty feet. Stalactites and stalagmites have been found in it, which are of the purest white, usually varying from three to eighteen inches in length, and from one to seven inches in diameter. One of a much larger size was removed entire, and is now in the possession of John Gebhard, Esq. Its base, which is of an elliptical form, is three feet six inches at the largest diameter, with a plane surface underneath; but its upper surfaces rise regularly on all sides to the centre, from which there is a column of fifteen by ten inches in diameter and seventeen inches in height. At the upper part there is a horizontal projection, from which are suspended forty-one stalactites from one to five inches in length. The weight of the entire mass is about four hundred pounds.

Nethaway's Cave, two miles southwest of Schoharie court-house, has furnished beautiful specimens of a honey yellow colour and columnar form; these columns or prisms being often terminated by three planes. They have been called arragonite; but all the specimens that I have examined easily give the rhombohedral form on cleavage, and I must therefore refer them to calcareous spar.

Young's Cave, in the town of Cobleskill, has also furnished fine specimens similar to those found at the two preceding, which have, like them, often been mistaken for arragonite. There is also a locality on Fox creek, two miles east of Schoharie, which deserves to be noticed. The calcareous spar is columnar, and terminated by triangular prisms like that from Nethaway's cave, and is of a yellowish white colour.

It would be unnecessary to notice more in detail these and other localities in this county. There are many caverns now known, which either have not been, or have been but partially, explored; all of which will undoubtedly afford specimens similar to those above described. And the mineralogist who is desirous of studying the various forms of carbonate of lime cannot be referred to a more interesting region than that which occurs within the circuit of a few miles from Schoharie court-house. He will also here enjoy the advantage of examining the fine cabinets of the Messrs. Gebhard, which will greatly assist him in his researches.

Ulster County. Calcareous spar, which cleaves easily in the direction of the primary planes, occurs in veins in Marbletown and elsewhere in this county. I am not aware that any interesting crystalline forms have been observed.

Warren County. On Diamond island, in Lake George, four miles north of the village of Caldwell, calcareous spar is found in small obtuse rhombohedrons, and in low six-sided prisms with three terminal planes (Fig. 63). These crystals are white or yellowish white, and are often transparent. They are associated with quartz and pearl spar, in geodes in the calciferous sandstone. Similar forms occur with the same associates at Diamond point, about a mile north of the above locality. Laminated masses are also found here, which are sometimes of considerable beauty. In the immediate vicinity of the village of Caldwell, on the

site of Fort George, there are veins of calcareous spar in the blue limestone, which are often of a very dark colour. Rarely regular crystalline forms are found.

Washington County. Crystals of the *lenticular* form are found in crevices in the rock at Baker's and Glen's falls.

Westchester County. Some years since, an abundant locality of crystals of calcareous spar, having the form of the *cuboïde* of Haüy (Fig. 80), were obtained from a vein in the primary rock, about half a mile south of the prison at Sing-Sing. Some of these crystals were very large, and a mass made up of an aggregate of them weighed nearly one hundred and fifty pounds. Similar crystals, but of much smaller size, are found in thin veins, in the gneiss near Yonkers. They are sometimes associated with analcime and iron pyrites, in minute but highly finished crystals.

MARBLE.

The term *marble* should perhaps be strictly confined to those varieties of carbonate of lime, whether included under the head of *granular* or *compact* limestone, which are susceptible of a polish, and some minerals of which carbonate of lime forms the principal ingredient. In a former part of this work (page 67), I have included under this head all those varieties of limestone which are, or may be, employed for ornamental building purposes, and have noticed in detail the principal localities which are known to occur in this State. I shall, therefore, only introduce here a short description of this variety of carbonate of lime, and refer the reader, who is desirous of further information, to the preceding part of this work just mentioned.

Description. The *foliated granular limestone*, or *crystalline marble*, is made up of distinct angular concretions, with a lower lustre and transparency than calcareous spar. These grains are of various sizes, from coarse to very fine. When this granular composition disappears, it becomes the *compact limestone*, which has a splintery or conchoidal fracture. Colour various, owing to the admixture of foreign substances; when white, it is more or less translucent. Specific gravity very variable, ranging from 2.40 to 2.84; the crystalline kinds being the most dense.

Composition. When pure, this variety has the same composition as calcareous spar, viz. carbonic acid 43.56, and lime 56.44; but it often contains variable proportions of silica, alumina and oxide of iron.

Dolomite, which in the former part of this work was included under the head of Marble, being a distinct mineral species, will be particularly described farther on.

FIBROUS LIMESTONE.

This variety of calcareous spar is composed of imperfect crystals or fibres, which are either coarse and adhere feebly, or are very delicate and firmly attached to each other, forming solid masses. These fibres are sometimes straight, at others curved, but are mostly parallel. The usual colours are white or grey, often with shades of yellow, red or green.

LOCALITIES.

Greene County. Thin veins of fibrous limestone occur at Catskill, which, when polished, resemble satin spar. The same mineral is found in the limestone near Natural bridge, in the town of Diana, Lewis county.

Onondaga County. At Camillus, this variety of carbonate of lime has been found in considerable abundance, and possessing great beauty. Its colours are snow-white, yellow and various shades of brown. It is susceptible of a good polish, both in the direction of, and across, the fibres. It has often, but incorrectly, been called arragonite. Its specific gravity is 2.629. It contains no strontia or baryta, as has been supposed. The white variety is a very pure carbonate of lime. The fibres are sometimes nearly two inches in length.

Orange County. Small veins, having the form and appearance of satin spar, have occasionally been found in the slate in this county. Tolerable specimens may be obtained at the quarry near the village of Sugarloaf.*

Schoharie County. Fibrous limestone is found in the town of Carlisle, seven miles northwest of Schoharie court-house, and near the celebrated locality of fibrous heavy spar. It is white, and usually has the fibres about three-quarters of an inch in length. It sometimes contains a small proportion of heavy spar. Indeed these two minerals seem to pass into each other by almost imperceptible gradations. They can easily be distinguished, however, by the difference in their specific gravity, and by the action of acids. They are both situated in layers between the strata of a soft slate.

St. Lawrence County. Near De Long's mill, satin spar has been found, with a beautiful lustre, and susceptible of a fine polish. The fibres are curved, and are about half an inch in length. Thin layers of a similar kind occur on the farm of Mr. Streeter, in the town of Rossie, near Caledonia mills.

Warren County. Carbonate of lime, in short delicate fibres, occurs abundantly in the slate near Glen's-Falls.

CONCRETED CARBONATE OF LIME.

Under this may be included all those varieties of carbonate of lime which exhibit imitative forms, resulting from the peculiar circumstances under which they have been produced. They are usually composed of a succession of layers nearly or quite parallel, whether straight,

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* Horton. *New-York Geological Reports*, 1839.

undulated or concentric. I include under this variety, the *Agaric mineral* of Cleaveland and other authors, as also the *Oolite* of mineralogists.

LOCALITIES.

Albany County. In the caverns which occur in the towns of Bethlehem and Knox, and which have been already noticed, stalactites and stalagmites, together with the variety often known by the name of *Calcareous sinter*, abound. These are often susceptible of a good polish. On the Patroon's creek, near the city, incrustations of carbonate of lime are also found, arising from the depositions of water charged with this mineral.

Allegany County. There are several beds of calcareous tufa about a mile and a half east of Portage; and two others have been observed near Rogers' bridge, but they are of inconsiderable extent.

In my notice of the localities of marl (page 83 et seq.), I omitted to state that two deposits occur in the town of Rushford; one overlying a swamp on the land of Judge McCall; the other near the road. There is also a small deposit at Caneadea, a little above the level of the valley. It is said, however, that it has not been used at either of these places for the manufacture of lime.*

Columbia County. In the rivulet which flows from the spring at New-Lebanon, there is deposited a calcareous substance of a botryoidal and reniform shape, which, if collected from a place where it has been undisturbed for a considerable time, resembles a stalagmite. Calcareous tufa is frequently met with in the limestone regions of this county. The spring which supplies the city of Hudson with water, is constantly depositing a calcareous tufa, which encloses sticks, reeds, helices, and in fact every substance with which it comes in contact. The deposit, however, is not extensive, and shows itself but little on the surface.†

Dutchess County. Calcareous tufa is quite common in the limestone regions of this county. Stalactites, stalagmites, and concreted carbonate of lime of various forms, may be seen in the *Spook hole*, a cavern near Barnegat.‡

Erie County. Near Ellicott's mills, there is a large deposit of calcareous tufa. Many tons of this newly formed rock are now suspended beneath the layers of the calciferous slate, and its volume is said to be constantly increasing by successive deposits.

Franklin County. About two miles from Chateaugay four corners, near the base of the high banks of sandstone between which the Chateaugay river flows, there is a large mass of calcareous tufa, which seems to have been deposited from a small brook running across its bed. It is used in the vicinity as a building material, and also in the manufacture of lime. The deposit is of considerable extent.

Greene County. On the Catskill and Canajoharie railroad, and near Catskill village, there are extensive deposits of calcareous tufa, which are formed by streams issuing from caverns in the limestone hills in the vicinity. Sometimes the limestone is covered with a thin and friable crust, which resembles the agaric mineral.

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* Hall. *New-York Geological Reports*, 1840. † Mather. Ibid. 1838. ‡ Ibid.

Jefferson County. Near Watertown, a white and pulverulent form of carbonate of lime is found covering the sides of a cave. It is sometimes from six to twelve inches in thickness. There are also stalactites and stalagmites of large size. And it is not uncommon, in this county, to find the *Chara flexilis* petrified, or partially changed into carbonate of lime.

Herkimer County. In a former part of this work (page 157), I have noticed the remarkable occurrence of tufa near the head of Otsquaga creek in the town of Stark. It may here be added, that on Frankfort creek, above the upper furnace, there is a similar deposit, in hard or tough, though thin, layers. Mr. Vanuxem states that it yields the whitest lime which he has seen in the State.* The lime is sent to Utica. Other localities of the concreted carbonate of lime occur in various parts of the county.

Livingston County. An interesting deposit of tufa, found near Caledonia, has already been described (see page 158). There are also valuable beds of marl. Similar localities are found in Madison County (see pages 85 and 158). To the remarks there made, it may be added, that the space to the south side of the village of Canastota, comprising the low grounds between the hills and the rise to the canal, seems to be entirely covered by lake marl and tufa. About a mile west of Chittenango, there is a deposit of calcareous tufa stained with oxide of iron. Attempts have been made to use it as an ore of iron, but without success.†

Monroe County. Stalactites of carbonate of lime, usually, however, of small size, are common on the under surfaces of the layers of limestone which form the banks of the Genesee river, near Rochester. Large masses of calcareous tufa are also found here, which exhibit almost all the forms and appearances elsewhere observed.

Montgomery County. Stalactites and stalagmites abound in Mitchell's cave, in the town of Root.

Niagara County. Tufa is found in many parts of this county, especially along the northern slope of the mountain ridge. At Niagara falls, calcareous incrustations are very common, and they assume every variety of imitative form, investing moss and other vegetables.

Onondaga County. On the track of the Auburn and Syracuse railroad, near the village of Camillus, deposits of carbonate of lime of various kinds are found in abundance. Some of them are in the cavities of the rock, and have a crystalline form; in other cases, they consist of incrustations resembling stalagmites (see Fibrous limestone, page 230).

Large masses of calcareous tufa are found in the low grounds on the Split-rock railroad, about a mile from Syracuse.

An immense deposit of tufa covers the side of the hill, and the road leading from Tully corners to Syracuse, on the west side of the Onondaga valley. It must be of great thickness; for neither the road which is cut into it, nor the ravines which pass through the tufa, reach the bottom. Lower down in the same valley, at about fourteen miles south of Syracuse, there is another deposit, but it is of limited extent when compared with the preceding one.‡

The depression in which the Messina spring is situated, is underlaid by tufa. This spring

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* *New-York Geological Reports*, 1838. † Ibid. 1839. ‡ Ibid.

is about three miles northeast of Syracuse (see page 146). Tufa is also extremely abundant between Camillus and Canton, and between Canton and Elbridge.

On Limestone creek, about three quarters of a mile north of the Fabius and De Ruyter road, is a fine deposit of tufa, in the state of earth, and in porous masses, the *horsebone limestone*. The earthy part is made into bricks, and burnt into lime. No lime can be whiter or purer than this; it is said to be highly valued.*

In various parts of this county, there are masses of calcareous tufa stained by oxide of iron (see page 36). One of these localities is about two and a half miles northeast of Salina. Mr. Vanuxem supposes the oxide of iron to be derived from the soil on which the tufa is deposited, and not from the water to which the tufa owes its origin.

Another locality of this iron-stained tufa is on Nine-mile creek, between Marcellus and the great embankment of the Auburn and Syracuse railroad.

Ontario County. Deposits of tufa are credited to the Clifton sulphur springs in the town of Phelps.

Orleans County. At the falls of Oak-orchard creek, at Shelby, calcareous tufa forms in large quantities from the decomposition of calcareous shales.†

Orange County. Snow-white calcareous sinter occurs in veins, and coating white limestone, near the village of Edenville. The same variety is found similarly situated in the blue limestone near Newburgh.

St. Lawrence County. Four miles northwest of the village of Gouverneur, there is a spring, the water of which covers the grass, moss and roots over which it flows, with carbonate of lime. And about two miles north of the same village, the variety called *agaric mineral* is found.

Saratoga County. Calcareous tufa is abundant in the vicinity of the Springs. What is called the "High Rock," is formed of this substance.

There is a bed of oolitic limestone about four miles north of Saratoga springs. It is of a dark colour, and is made up of rounded grains, which are about as large as a pin's head. On analysis, I found its composition to be as follows:

Carbonate of lime,	95.00
Silica and alumina, with some carbonaceous matter,	5.00

It should be distinctly stated that the term *oolite*, applied to this limestone, only has reference to the peculiarity of its structure, and is used in the mineralogical, and not the geological sense. The same structure is also observed in some of the limestones of Orange county; but it is well known that the true oolitic series does not occur in these counties, nor in any part of the State. I am the more particular in making this explanation, from the incorrect inferences which have been drawn from the use of the term *oolite* in one of my annual reports.

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* Vanuxem. *New-York Geological Reports*, 1839.

† Hall. Ibid. 1838.

Schoharie County. Calcareous tufa is found in considerable abundance in various parts of this county. It occurs on the sides of the mountains, exhibiting a number of imitative forms. Also near the springs in the town of Sharon, where there is a mass averaging two hundred yards in length, fifty in breadth, and ten in depth, which has all been precipitated from these waters. Helices, leaves of trees, and moss, are constantly incrusted with this calcareous deposit, and almost all kinds of imitative forms can be procured.*

Another locality of this variety of carbonate of lime occurs about one mile and a quarter west of Schoharie, on the road to Cobleskill. It is loose, and can be shovelled up. It may be called a *tufaceous marl*, and may be used for agricultural purposes.†

Four miles northwest of Schoharie court-house, on Cobles kill, is a deposit of loose and friable tufa or agaric mineral of some extent (see page 87).

There are other localities in this county, but they are not supposed to be of such extent as those already noticed. It may be remarked, that the caverns with which this county abounds, and which have already been briefly described (page 228), afford specimens of almost every variety of carbonate of lime. It is not necessary, however, again to recapitulate these localities.

Steuben County. There is a bed of tufa, which is not, however, supposed to be of much extent, in a hill northeast of Danville, on the land of Mr. Brewer. It has been used in the manufacture of lime. Large quantities are obtained for that use, at another locality in the same town. On the Canisteo, a mile and a half from Bennetsville, a spring, rising at a level of sixty or seventy feet above the river, deposits calcareous matter, and there are several other springs of a similar kind in the vicinity.

Two miles east of Arkport, tufa is burned for lime, from which that part of the county is supplied. So also at Pogue's Hole on the Canaseraga, at Troupsburgh and at other places, tufa and marl are used for the same purpose.‡

Tompkins County. Near the village of Ithaca, there are deposits of calcareous tufa investing moss and other vegetable forms. The specimens are quite similar to some of those from Genesee and Niagara falls.

Ulster County. There is a locality of calcareous tufa at the foot of a ledge of limestone on Stony creek, on the land of Mr. David Schoonmaker, in the town of Rochester. And about fourteen miles southwest from Esopus, there is a cavern in which are found stalactites, stalagmites, etc.

Washington County. Calcareous tufa is deposited from the waters of springs near Whitehall, and the variety satin spar has been found at Argyle.

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* Mather. *New-York Geological Reports*, 1840. † Ibid. ‡ Hall. Ibid. 1840.

MARL.

This substance, which, when pure, contains little else than carbonate of lime, has already been noticed in detail (see page 83).

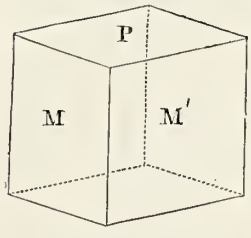
ARRAGONITE.

[From its having been first found in the province of *Arragon* in Spain.]

Arragonite. *Haüy*, *Cleaveland*, *Phillips*, *Thomson* and *Shepard*. — Prismatic Limestone. *Jameson*. — Prismatisches Kalk-Haloid. *Mohs*. — (It has also been called Igloite, Flos Ferri, and Needle Spar. Beudant places it as a subspecies under Carbonate of Lime.)

Description. Colour usually white, but sometimes with a shade of grey, yellow, green and blue. It occurs regularly crystallized; also in prismatic concretions, and massive. The primary form is a right rhombic prism. Fig. 101. M on M′ 116° 5′ (*Phillips*). Three of the crystals are often grouped together so as to constitute a six-sided prism. Cleavage parallel with the lateral planes of the primary. Fracture conchoidal, passing into uneven. Lustre vitreous, inclining to resinous. Transparent and translucent. Brittle, and even frangible. Hardness from 3.5 to 4.0. Specific gravity from 2.92 to 2.94. Thin fragments of transparent crystals decrepitate in the flame of a candle; other varieties lose their translucency, and become friable. With borax, it dissolves, and forms a transparent glass, which crystallizes on cooling; but in soda, it is insoluble. It phosphoresces on hot iron, and dissolves with effervescence in nitric and muriatic acids.

Fig. 101.



Arragonite oftentimes so closely resembles calcareous spar, that it is very difficult to distinguish it. The crystalline form, when it can be determined, is always a safe guide. The specific gravity of arragonite is also higher than that of calcareous spar. The blowpipe characters cannot, I think, in all cases be depended on.

From the fact that some of the foreign specimens of arragonite are fibrous, many of our fibrous carbonates of lime have received that name in American cabinets. But I have reason to believe that arragonite is rare in the United States; there are certainly but few localities of it in the State of New-York.

Composition. The chemical composition of this mineral does not differ from that of calcareous spar, except that it contains, in most instances, minute, but very variable, proportions of water and of the carbonate of strontia. In ten analyses of Stromeyer, the water varies from 0.154 to 0.599, and the carbonate of strontia from 0.509 to 4.013. It is now, however, ascertained that these last ingredients are not always present, and that the peculiar crystalline form of this mineral is not due to them. Indeed, M. Gustave Rose has shown that arragonite may be prepared artificially, without the addition of a particle of strontia. When a simple solution of carbonate of lime in carbonated water is evaporated in a water

bath to dryness, a loose crystalline powder is obtained, which, under the microscope, appears for the greatest part as an aggregation of distinct crystals, which manifestly have the form of arragonite. They generally appear as six-sided columns somewhat dilated, or as very acute six-sided double pyramids, like many sapphire crystals; at times, however, they appear as single pyramids, so that they are therefore crystallized differently at the two ends. But when a similar solution is allowed to stand several weeks in an open glass at common temperatures, the microscopic crystals, which are found partly on the sides of the vessel and partly on the surface of the solution, are always found to have the form of the primary rhombohedron of calcareous spar. The method which Rose recommends for obtaining arragonite quite pure, and free from calcareous spar, is to pour a hot solution of chloride of calcium into a hot solution of carbonate of ammonia. The crystals are exceedingly minute, and have a specific gravity of 2.949.

Rose also remarks, that in order to preserve unchanged the arragonite obtained by precipitation, it is necessary to wash and dry it immediately. If it is allowed to stand after precipitation for any length of time in the fluid, it is in a very curious manner gradually converted into calcareous spar. This metamorphosis, however, seems only to take place when the arragonite is newly precipitated. If it has been well dried first, it remains quite unchanged, even if it be now re-immersed in water or carbonate of ammonia, and allowed to stand in it for weeks.

In the progress of these experiments, it was also ascertained, that when arragonite is exposed to a low red heat, it is changed into calcareous spar, the large crystals falling in a coarse powder; the smaller ones retaining at the same time their form, and producing pseudo-morphous crystals.

For the purpose of still further testing the question whether the carbonate of strontia is necessary to the formation of arragonite, Rose mixed a small quantity of a solution of chloride of strontia with a solution of chloride of lime, but by precipitation at the common temperature with carbonate of ammonia, crystals of calcareous spar only were perceivable.*

LOCALITIES.

Niagara County. Shepard states that the variety called *Flos ferri* has been found coating gypsum in geodes at Lockport.†

Orange County. Specimens of what I suppose to be arragonite, have been found in cavities in the magnetic iron ore at the Wilks and O'Neil mines in the town of Monroe. The colour is white or yellowish white; it is mammillary, botryoidal, fibrous, and in imperfect crystals. The fibres are coarse, straight or stellated. Probably the same mineral occurs at Edenville in this county, lining cavities of mispickel and cube ore.

Schoharie County. According to Shepard, a fibrous variety of this species is found in Ball's cave, where it is said to form stalagmites and stalactites; but all the specimens which I have examined, appear to me to be nothing more than calcareous spar.

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* On the Formation of Calc Spar and Arragonite. By Gustave Rose. *Lond. and Edin. Phil. Mag.* &c. 3d Series. XII. 465.

† *Treatise on Mineralogy.* I. 42.

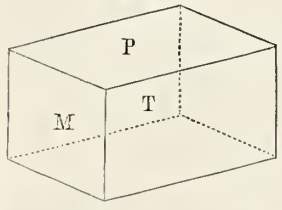
St. Lawrence County. Coralloidal arragonite is credited by Dr. Emmons to the Parish iron ore bed in the town of Rossie. Although this situation is favourable to the occurrence of this mineral, all the specimens which I have seen, and they are quite numerous, belong to the preceding species.

GYPSUM.

[*Gypse* is said to have been the ancient name of calcined sulphate of lime.]

Chaux Sulfatée. *Haüy.* — Sulphate of Lime. *Cleaveland.* — Hydrous Sulphate of Lime. *Thomson.* — Prismatoidal Gypsum, or Common Gypsum. *Jameson.* — Prismatoidisches Gyps-Haloid. *Mohs.* — Gypse. *Beudant.* — Gypsum. *Phillips, Shepard* and *Dana.*

Fig. 102.



Description. Colour snow-white when pure, but it is often also yellow, red, blue, grey, green, brown and even black. It occurs regularly crystallized; also foliated, fibrous, granular and compact. The primary form is a right oblique angled prism. Fig. 102. M on T 113° 8′. Cleavage highly perfect parallel with P, imperfect parallel with M and T. Fracture splintery. Lustre of the lateral faces of the prism, vitreous; that of the base, pearly. Varies from transparent to translucent on the edges. Hardness from 1.5 to 2.0; may be scratched by the nail. Specific gravity from 2.20 to 2.40. Before the blowpipe it exfoliates and melts, but with difficulty, into a white enamel. At a lower heat, the water which it contains is driven off, and it becomes friable. If then reduced to powder and mixed with water, the powder becomes warm, and soon hardens into a solid mass.

This mineral may be distinguished by its inferior hardness, and by its not effervescing in acids, from the carbonate of lime, which it sometimes closely resembles. The powder of fluor spar is decomposed by sulphuric acid, with the evolution of the hydrofluoric acid.

Varieties. The transparent and highly crystallized varieties are called *Selenite;* those disposed in fibrous concretions, *Fibrous Gypsum;* those which have a splintery fracture, *Compact Gypsum* or *Alabaster.* Some varieties, composed of fine scaly or dusty and slightly cohering particles, are named *Earthy Gypsum,* a term which is also applied to the impure kinds used in agriculture.

Composition. Sulphuric acid 46.00, lime 33.00, water 21.00. Formula $CaO.SO_3+2Aq$.

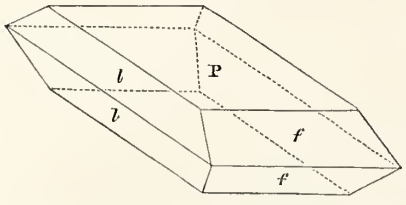
LOCALITIES.

In a former part of this work (page 62), I have noticed in detail the most important localities of this mineral, with reference to its use in agriculture and the arts. I shall therefore only introduce here those notices which are interesting in a mineralogical point of view.

Albany County. Specimens of snowy gypsum have been found in the Helderberg mountains; and in the town of Coeymans, it occurs in an alluvial bed twenty or thirty feet in thickness, forming efflorescences on the sides of excavations made for roads, etc.

The finest specimens of the foliated variety, the *Selenite*, or *Isinglass plaster*, as it is usually called, in the western part of the State, is near the village of Camillus in Onondaga county, where folia of large size and nearly transparent have been found. With these specimens, both here and near the Split-rock quarry, the fibrous variety has also been obtained of considerable beauty. The fibres, however, are coarse, and want the beautiful lustre of the foreign specimens. Similar varieties are often met with in all the more extensive plaster beds of the western counties. Sometimes also imperfect crystalline forms are observed.

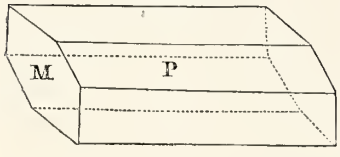
Fig. 103.



In the vicinity of Manlius, crystals are occasionally found, having the form of the *trapézienne* of Haüy. Fig. 103. P on f 124° 41′ 43″; P on l 108° 3′ 19″; f on f 110° 36′ 34″; l on l 143° 53′ 22″.

Niagara County. Fine specimens of selenite and snowy gypsum have been obtained in considerable abundance in the vicinity of Lockport. They occur in nodules in the limestone, associated with the beautiful calcareous and pearl spar and anhydrite. Snow-white granular gypsum also occurs in the same rock near the Falls of Niagara, with occasional specimens of selenite.

Fig. 104.



Schoharie County. Gypsum is deposited in very minute crystals, from the waters of the Sharon sulphur spring. They are white and transparent, and the usual form is similar to the accompanying figure (104), the longer terminal edges of the primary being replaced by new planes.

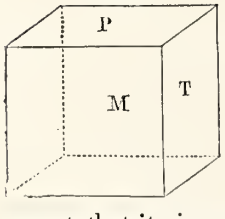
ANHYDRITE.

[From the Greek ανύδρος, in allusion to its being without water.]

Chaux Anhydro-sulfatée. *Haüy.* — Anhydrous Sulphate of Lime. *Cleaveland.* — Prismatic Gypsum, or Anhydrite. *Jameson.* — Prismatiches Orthoklas-Haloid. *Mohs.* — Muriacite. *Werner.* — Karstenite. *Beudant.* — Anhydrite. *Phillips, Shepard* and *Dana.*

Description. Colour white, blue, red and grey. It is sometimes crystallized; and when its structure is foliated, it is easily cleavable into a right rectangular prism, which is the primary form, Fig. 105. It also occurs in granular, fibrous, and lamellar concretions; massive, and vermicularly convoluted or contorted. Fracture splintery and conchoidal. Lustre vitreous, inclining to pearly. Varies from transparent to translucent on the edges. Hardness from 3.0 to 3.5. Specific gravity from 2.70 to to 3.00. Before the blowpipe, it behaves like the preceding species, except that it gives out no water; and this, together with the difference in crystalline form, will sufficiently distinguish it.

Fig. 105.



Composition. Sulphuric acid 58.00, lime 41.70, water 0.7, silica 0.09 (*Stromeyer*). The two last, however, are accidental ingredients. It also sometimes contains a minute proportion of common salt. Formula $CaO.SO_3$.

Geological Situation. This mineral is found massive and in beds in the salt and secondary gypsum formations. It is frequently intermixed with rock salt, also with stinkstone, saliniferous clay, and occasionally with ores of different kinds. Some varieties are met with in transition and primitive rocks. The former is its situation in the State of New-York. Several of the varieties are found in the red sandstones of England and Scotland.

LOCALITIES.

Niagara County. At Lockport, this mineral occurs foliated, transparent or translucent, and of a blue colour, in geodes in the limestone. The decomposed mineral, *épigène* of Haüy, also occurs at the same locality, in thin coatings upon the foliated variety, and also filling up crevices of the folia. From the foliated mineral, the primary form can be obtained by cleavage. It is often mixed with carbonate of lime, so that fragments thrown into an acid, effervesce. Sometimes, also, it contains a considerable proportion of water, although its crystalline arrangement is unaffected. It is not easy to determine to what extent this change has taken place, and how far the masses of common gypsum found at Lockport may have resulted from causes which have operated subsequently to the original deposition.

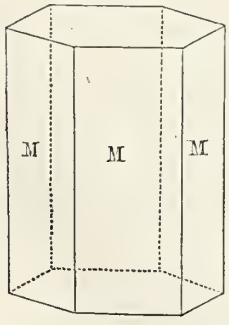
With the exception of the preceding, I know of no other locality of anhydrite in this State. The minute crystals found at the Sharon springs in Schoharie county, have often passed by this name among our mineralogists, but those that I have seen belong to the preceding species.

APATITE.

[From απαταω, *to deceive;* from its being easily mistaken for other minerals.]

Chaux Phosphatée. *Haüy.* — Phosphate of Lime. *Cleaveland.* — Rhombohedral Apatite. *Jameson.* — Rhomboedrisches Flus-Haloid. *Mohs.* — Subsesquiphosphate of Lime. *Thomson.* — Apatite. *Phillips, Beudant, Shepard* and *Dana.*

Fig. 106.



Description. Colour white, green, blue, red, yellow and brown; usually dull. It occurs regularly crystallized; also massive and disseminated. The primary form is a regular six-sided prism. Fig. 106. M on M 120°. Cleavage parallel with the sides and base of the primary, but difficult. Fracture conchoidal and uneven. Lustre resinous, and varying from splendent to glimmering. Alternates from transparent to feebly translucent on the edges. Brittle and easily frangible. Hardness 5.0. Specific gravity from 3.00 to 3.30. Before the blowpipe, it is very difficultly fusible. With borax or biphosphate of soda, it melts easily into a glass. It fuses also when mixed with carbonate of iron. It is dissolved in nitric and muriatic acids, and the solution is abundantly precipitated by oxalate of ammonia.

Its solubility and inferior hardness will serve to distinguish apatite from chrysoberyl, topaz, emerald, etc., which it sometimes resembles. It does not effervesce when treated with acids, nor does it give out hydrofluoric acid, except in small quantities, when acted on by sulphuric acid. By these negative characters, it can be distinguished from the carbonate of lime and fluor spar. Wagnerite is soluble in dilute sulphuric acid, which is not the case with apatite.

Composition. Phosphoric acid 44.32, lime 55.66 (*Rose*). It usually contains also minute proportions of fluoric and muriatic acids.

Geological Situation. Apatite occurs in gneiss, granite, and white limestone. The fibrous variety, *Eupyrchroite* of Emmons, is found in limestone in the town of Crown-Point, Essex county.

LOCALITIES.

Essex County. According to Dr. Emmons, this mineral occurs at Long pond, associated with garnet and idocrase ; and it has also been found in brown six-sided prisms, generally half an inch long, in granular oxide of iron.*

The magnetic iron ore at the Sanford mine in East-Moriah, is often thickly studded with small six-sided prisms of apatite, with imperfect terminations. The same mineral is also found, but more sparingly disseminated, in the ore of the Hall mine, near the preceding. This, although an interesting mineral, is one of the most troublesome associates of iron ore (see page 15).

About a mile south of Hammondsville, in the town of Crown-Point, there is found a fibrous variety of this mineral, which was described by Dr. Emmons under the name *Eupyrchroite*. The colour is pale malachite green, passing into greenish white, and sometimes brownish. Structure indistinctly fibrous in the thin mammillated layers, which are arranged like those of green malachite. Dull and opaque. Hardness 4.0. Specific gravity 3.06.†

According to my analysis, the composition of this mineral is as follows :

Phosphate of lime,	92.85
Oxide of iron, with a little alumina,	5.20
Silica (foreign),	0.50
Water,	1.50
Fluoric acid,	traces.

The oxide of iron, silica and alumina, are undoubtedly accidental impurities, as it is almost impossible to obtain masses which are entirely free from the accompanying rock. The presence of fluoric acid can be shown, by reducing the mineral to powder, and then mixing it with sulphuric acid in a platinum crucible. Upon covering the crucible with a plate of glass, and applying a gentle heat, the glass is soon corroded. In this way, I have also detected that acid in the crystallized phosphate of lime of Orange and St. Lawrence counties.

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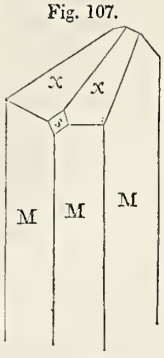
* Morton. *Cleaveland's Mineralogy.*

† Emmons. *New-York Geological Reports*, 1838.

Fig. 107.



Jefferson County. In the white limestone on the bank of Vrooman lake, six-sided crystals of apatite occur, from half an inch to five inches in length. They are of a fine green colour, and have their terminations sometimes modified, as in the annexed Fig. 107. M on *s* 135°; M on *x* 129° 13′ 53″; *x* on *x* 143° 7′ 48″.

Lewis County. This mineral occurs in imperfect crystals, and in folia of an emerald green colour, in the town of Diana, near Natural bridge. It is associated with feldspar, scapolite, pyroxene and sphene; the whole being in white limestone.

New-York County. At Corlær's Hook, it has been found both amorphous and crystallized. It is usually in apple-green prisms, sometimes imperfect, either long and slender or short and thick, imbedded in granite. It has also been obtained elsewhere on the island of New-York, from veins of quartz traversing mica slate, in pale or deep green prisms from two to four inches in length.* I am not aware that this mineral has been recently found at these localities.

Orange County. In this county, so rich in its mineral resources, there are several localities of apatite. About three-fourths of a mile from Edenville, the late Dr. Young, of that village, found a locality at which he obtained well defined six-sided crystals, from half an inch to twelve inches in length, and from an eighth to one inch and five-eighths in diameter.† They are often of a bright asparagus-green colour, and are engaged in white limestone. Fig. 108 and 109 represent the forms which have been observed; the former being the *pyramidée* of Haüy; the latter having the edges of the prism and pyramid replaced by tangent planes, M on *e* 150°. I have found these crystals to contain a minute portion of fluoric acid.

Fig. 108.

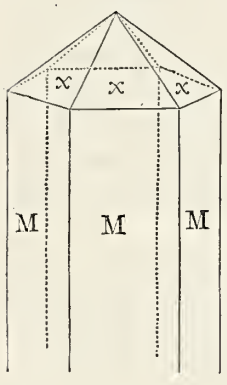
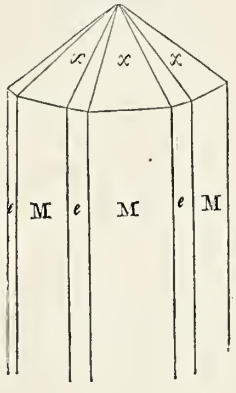


Fig. 109.



In the same vicinity, Dr. Horton has found pale blue crystals of a modified form, associated with sphene in calcareous spar; and others, of a greenish white, greyish white, or greyish green colour, associated with mica and hornblende.

About two miles south of the village of Amity, Mr. Nuttall, many years since, found a locality from which were obtained very fine and perfect crystals of an emerald and bluish green colour, and nearly transparent. Small and imperfect crystals are also found near Two ponds in the town of Monroe, and occasionally specimens are met with at the Forshee iron mine.

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* Pierce and Torrey. *Cleaveland's Mineralogy.*

† *American Journal of Science.* XXIII. 403.

Putnam County. Minute crystals of apatite, having a bluish green colour, are found associated with pyroxene in Philipstown. They are, however, scarcely worth collecting as cabinet specimens.

St. Lawrence County. Specimens have here been found of a size entirely unknown before. At Robinson's farm, in the town of Hammond, a crystal has been found nearly a foot in length, and weighing eighteen pounds! This, however, is not entirely perfect; but perfect crystals of a smaller size are abundant. They are six-sided prisms with six-sided pyramids (Fig. 108). Colours deep green, pale green and light blue. They are associated with zircon and feldspar, in a gangue of calcareous spar. Many of the specimens are remarkable for the proofs which they exhibit of having undergone fusion subsequently to the time of their formation. Sometimes the terminations are rounded; and at others, the whole crystal is bent as in the accompanying Figs. 110 and 111. The crystals also have a glassy appearance on the surface. I have observed the same rounded terminations in some of the specimens from Orange county. Dr. Emmons considers this as one of the proofs in favour of his theory of the igneous origin of primitive limestone.*

Fig. 110.

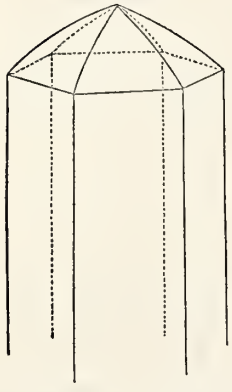


Fig. 111.

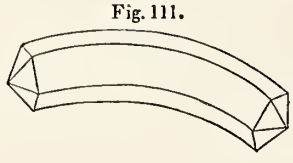


Fig. 112.

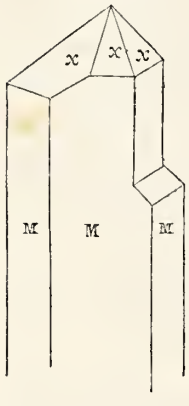
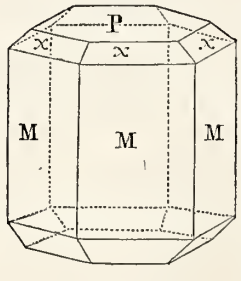


Fig. 113.



Compound crystals similar to that represented in Fig. 112, have also been obtained at the preceding locality.

About a mile southwest of the village of Gouverneur, six-sided prisms have been found in the limestone, from four to six inches in length, and having a sea-green or mountain-green colour, associated with scapolite and smoky quartz. These crystals sometimes have the form of the *uniannulaire* of Haüy. Fig. 113. M on x 129° 13′ 53″; P on x 140° 46′ 7″. At present, however, it is not easy to obtain good specimens at this locality.

Small but well defined six-sided crystals of this species are found accompanying sphene, pargasite, pyroxene and feldspar, in the town of Rossie, two miles north of the village of Oxbow. They are bluish green and translucent. Small sky-blue crystals have also been obtained from the limestone in the neighborhood of the village of Rossie, in this county.

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* *New-York Geological Reports*, 1838.

Saratoga County. In the town of Greenfield, a mile from the springs, apatite has been found in reddish brown crystals an inch or more in length, in a vein of granite, associated with chrysoberyl, tourmaline and garnet.*

Westchester County. Apatite, in low six-sided prisms truncated on the terminal edges (Fig. 113), has been found at Anthony's Nose. These crystals are of a brownish or yellowish green colour, and vary from half a line to an inch in length. They are either perfect or have their angles rounded, and generally present two faces broader than the other four. This locality is believed to have been first noticed by Dr. G. Troost.†

This mineral also occurs at Yonkers and West-Farms, where it is associated with tourmaline and garnet; but no very good specimens have yet been obtained at these localities.

FLUOR SPAR.

Chaux Fluatée. *Haüy.* — Fluate of Lime. *Cleaveland.* — Fluor Spar. *Phillips* and *Thomson.* — Octahedral Fluor. *Jameson.* — Octaedrisches Flus-Haloid. *Mohs.* — Fluor. *Kirwin* and *Shepard.* — Fluorine. *Beudant.*

Fig. 114.

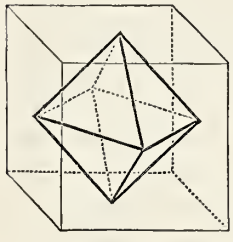
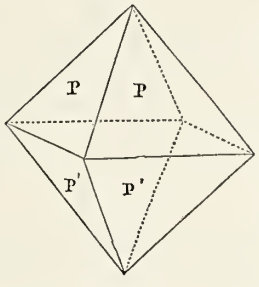


Fig. 115.



Description. Sometimes transparent and colourless; but more frequently white, grey, black, blue, green, yellow, red or brown. It crystallizes in cubes, which are cleavable into octahedrons and regular tetrahedrons, Fig. 114. The primary form is the regular octahedron, Fig. 115. It also occurs massive and disseminated, nodular and earthy. Lustre vitreous. Varies from translucent to transparent. Brittle and easily frangible. Hardness 4.0. Specific gravity from 3.10 to 3.20. Before the blowpipe, it decrepitates, and at length fuses into an opaque enamel. It is attacked by acids.

When fluor spar is acted on by sulphuric acid, it evolves a gas which corrodes glass; and it may thus be distinguished from calcareous spar. It is also harder than the latter mineral.

Composition. According to the researches of the most able chemists, this mineral, in its pure form, is composed of fluorine 48.13, and calcium 51.87; but is most commonly mixed with silica and other foreign substances. Its formula is CaF.

Geological Situation. It occurs in veins and beds in gneiss, mica slate and clay slate, in various metalliferous formations of cobalt, silver, tin, lead, copper, etc.; less frequently in transition rocks and very abundantly in some secondary rocks, as limestone. In New-York, it is found in series of calcareous spar, in gneiss and in various calcareous limestones.

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* Shepard. *Treatise on Mineralogy*, 1835. † *Memoirs of the Academy of Natural Sciences of Philadelphia.* II. 55.

Uses. This mineral is sometimes used as flux for certain ores. Some of the varieties have also been employed in the manufacture of vases and other ornamental articles.

LOCALITIES.

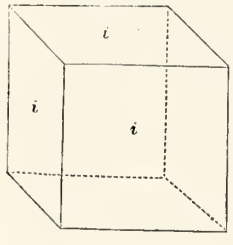
Cayuga County. Fluor spar is found in small quantities in the grey sparry limestone, at the quarry of the New-York Company at Auburn; and also in the water-lime series, just above the limestone on the road from Cayuga bridge to Auburn.*

Clinton County. This mineral, in green and occasionally purple masses, is sparingly disseminated in the gangue of the iron ore at the Arnold mine.†

Genesee County. Nearly black crystals have been found in this county, but they are not of frequent occurrence.

Jefferson County. One of the most remarkable localities of fluor spar in the United States, is that which occurs on the southeast bank of Muscolunge lake, in the town of Alexandria, about four miles northwest from the village of Oxbow. The mineral is in a vein of considerable width, associated with calcareous spar, and running vertically or nearly so through a bed of primitive limestone. Cubical crystals (Fig. 116) of various sizes have been found here, some of them more than a foot in diameter. These crystals have a greenish tint, and in small cleavages are translucent. Sometimes, however, they are nearly colourless. The faces of the larger ones are usually rough, but the smaller ones are more perfect, and have a better finish. In consequence of the extensive excavations which have been made for the removal of this mineral, it is now difficult to obtain good crystallized specimens, and there is some danger in working at the locality. Massive specimens, however, are abundant, and from these the octahedron can usually be obtained by cleavage. A short distance north of the preceding, there is probably another vein of this mineral, as small loose crystals were found in considerable abundance on the lake shore.

Fig. 116.



Lewis County. Green and nearly transparent crystals are found in narrow veins in the limestone at the falls near Lowville. They are usually in the form of cubes, rarely in octahedrons. They are associated with calcareous spar, iron pyrites, and rarely galena. The specimens are liable to injury from the decomposition of the iron pyrites, and should be covered with gum arabic or copal, to protect them from the action of the atmosphere. The same mineral is occasionally met with, similarly associated, at Martinsburgh in this county.

Monroe County. Cubical crystals, transparent and colourless, or with a beautiful bluish tint, have been found in cavities in limestone near Rochester. These crystals are sometimes an inch in diameter, but they are usually much smaller. They have an exquisite finish.

Niagara County. Fluor spar occurs in small colourless cubes at Lockport, where it is associated with the calcareous and pearl spar, celestine, etc., which have rendered this region

* Vanuxem. *New-York Geological Reports*, 1839. † Emmons. Ibid. 1840.

so celebrated among mineralogists. It is, however, by no means abundant. On Goat island, it is found with similar associates in straw-yellow, and rarely dark purple cubes, in the fetid limestone. The specimens do not possess much beauty.

Onondaga County. Cubes of a deep and beautiful purple colour may be seen in the seams of white calcareous spar which traverse the hydraulic limestone in the quarry near Manlius. The fluor is also sometimes in imperfect crystals, and in grains.

Orange County. At Edenville and Amity in the town of Warwick, fluor spar of a dark purple colour occurs in grains, and rarely in cubic crystals. It is sometimes associated with scapolite, and at others with talc or mica and brucite, in calcareous spar.

Saratoga County. Small specimens nearly colourless, and penetrated by pyrites, are said to have been found in limestone near the Springs.*

St. Lawrence County. There are several localities of fluor spar in this county. Near Rossie it occurs in crystals of a purple colour, in calcareous spar, and sometimes exhibits the form of the *cubo-octaèdre* of Haüy. Fig. 117. P on *i* 125° 15′ 52″. This mineral has also been found, accompanying galena, at Mineral point in Morristown; and large dodecahedral crystals, Fig. 118, have been obtained in the town of De Kalb, but with the precise locality I am unacquainted. They have the green tint of the specimens from Muscolunge lake.

Fig. 117.

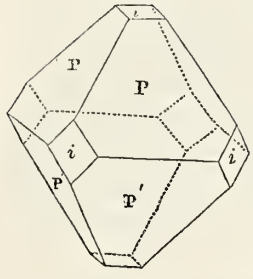
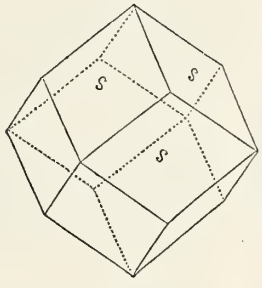


Fig. 118.



Warren County. Beautiful and highly modified crystals of fluor spar have been found by Dr. Emmons, in the vicinity of Johnsburgh.

MURIATE OF LIME.

Chloride of Calcium, *of Chemists.*

Description. This salt is found in several of our mineral springs, and in small quantities also in the water of some wells. It is very soluble in water; and when evaporated by the application of heat, it crystallizes on cooling in the form of long striated rhombic prisms. It is very deliquescent. Its presence may be detected in waters, by the addition of solutions of nitrate of silver and of oxalate of ammonia to separate portions. In each case there is formed a white precipitate if muriate of lime is present.

Composition. Calcium 18.64, chlorine 32.27, water 49.09. Formula CaCl+6Aq.

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* *Cleaveland's Mineralogy.*

Uses. This salt, which is abundantly procured as a residue of the preparation of carbonic acid, etc., is employed, in consequence of its great attraction for water, to dry gases for experimental purposes, and to separate water from various liquids. When heated so as to undergo watery fusion, there is obtained a powder which is used in the preparation of freezing mixtures.

DATHOLITE.

[From the Greek, signifying *turbid.*]

Chaux Boratée Siliceuse. *Haüy.* — Siliceous Borate of Lime. *Cleaveland.* — Prismatic Datolite. *Jameson.* — Prismatischer Distom Spath. *Mohs.* — Borosilicate of Lime. *Thomson.* — Datholite. *Beudant, Shepard* and *Dana.* — (It includes Esmarkite, Humboltite and Botryolite. Thomson, however, describes the latter as a distinct species.)

Fig. 119.

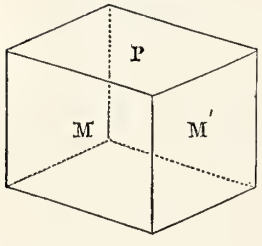
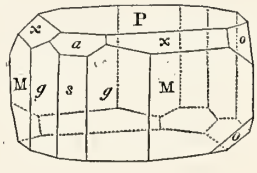


Fig. 120.



Description. Colour greyish or greenish white, rarely red and yellow. It occurs regularly crystallized and massive. The primary form is a right rhombic prism, Fig. 119. M on M′ 103° 40′ (*Phillips*). Fig. 120 is one of the secondary forms. Cleavage obtained with difficulty. Fracture uneven, conchoidal. Lustre resinous or pearly. From transparent to opaque. Hardness from 5.0 to 5.5. Specific gravity from 2.90 to 3.00. When exposed to the flame of a candle, it becomes opaque, and crumbles down between the fingers. Before the blowpipe, it intumesces into a white mass, and then melts into a transparent or pale rose-coloured globule. It readily dissolves in, and gelatinizes with, nitric acid. If spirit of wine is burned upon the jelly, the flame is coloured green.

Composition. According to Klaproth, it is composed of silica 36.50, lime 35.60, boracic acid 24.00, water 4.00. The *Botryolite* contains, according to the same chemist, silica 36.00, lime 39.50, boracic acid 13.50, oxide of iron 1.00, water 6.50.

Geological Situation. This mineral occurs in fissures and cavities in the greenstone and amygdaloid in New-York, and the contiguous parts of New-Jersey.

LOCALITIES.

New-York County. This mineral is found in small quantities in cavities and veins in the greenstone boulders which are strewed over various parts of the island.

Rockland County. At Piermont, where the New-York and Erie railroad passes through the greenstone, specimens of datholite have occasionally been found. They are highly modified crystals. The finest specimens have, however, been obtained from fissures in this range

at Bergen hill. Crystals of the primary form (Fig. 119), and very complex secondary ones, have been found here in considerable abundance. They sometimes very nearly resemble those of calcareous spar, occurring at the same locality, and the latter have probably often been mistaken for them. The different action of acids forms a good distinctive character. Datholite is also found in the trap at Paterson, and in other parts of New-Jersey.

Westchester County. Small crystals, presenting the primary form slightly modified, have been found in veins of calcareous spar, with analcime and iron pyrites, in the gneiss near Yonkers. They are, however, of rare occurrence.

According to Prof. Shepard, the variety *Humboltite* occurs in trap at Middlefield and Hamden, Connecticut.

PHARMACOLITE.

[From the Greek φαρμακος, in allusion to its containing poison.]

Chaux Arseniatée. *Haüy.* — Arseniate of Lime. *Cleaveland.* — Bisesquihydrous Arseniate of Lime. *Thomson.* — Hemiprismatic Gypsum-Haloide. *Haidinger.* — Hemiprismatisches Euklas-Haloid. *Mohs.* — Pharmacolite. *Beudant*, *Shepard* and *Dana.*

Description. Colour white or greyish white. It occurs in minute fibrous or acicular crystals, which are usually aggregated into botryoidal or globular masses; more rarely in distinct crystals. The primary form is a right oblique angled prism (Fig. 121). Fig. 122 represents one of the secondary forms: f on f 117° 24′; o to the edge between f and f 83° 14′. Cleavage parallel to T, highly perfect, and easily obtained. Fracture uneven. Lustre glimmering or silky. Transparent or translucent. Hardness 2.0 to 2.5. Specific gravity 2.73. Before the blowpipe, it is almost entirely volatilized with a dense white arsenical vapour. In nitric acid, it dissolves readily without effervescence.

Fig. 121.

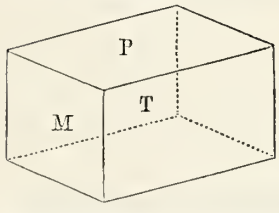
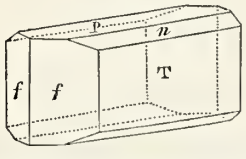


Fig. 122.



Composition. Lime 25.00, arsenic acid 50.54, water 24.46 (*Klaproth*).

In regard to this mineral, it may be remarked, that most of the above characters were obtained by Haidinger from a specimen which he supposed to come nearer to pharmacolite than to any other species. It was received by him under the name of *selenite*. His remarks are as follows: "It is very likely not an entirely new species, but a variety of pharmacolite, now observed for the first time in crystals large enough to admit of measurement, and to allow the characters derived from hardness and specific gravity to be ascertained to a considerable degree of exactness. The pharmacolite itself cannot be called a species which we know, since the whole of our information respecting its natural-historical properties is confined to its occurring in exceedingly delicate white capillary crystals, aggregated in globules, the specific gravity of which is 2.64. The lower specific gravity might perhaps be accounted

for by the delicacy of the crystalline groups employed. In other respects, the opinion that the variety described above, and the acicular globules of pharmacolite, belong to the same species, is grounded solely on the analogy of resemblance existing between the former with crystals of gypsum, and between the latter and the radiated groups so frequently observed in the same species." According to Dr. Turner, the crystallized mineral described by Haidinger is composed of arsenite of lime 79.01, water 20.99.*

LOCALITIES.

A mineral apparently belonging to this species, has been found by Dr. Horton in magnetic iron ore, in the town of Monroe, Orange county.

ORDER IV. MAGNESIA.

This order embraces the following minerals, viz:

1. Brucite (Hydrate of Magnesia.)
2. Carbonate of Magnesia.
3. Epsom Salt.
4. Magnesian Carbonate of Lime.
5. Hydrobromate of Magnesia.

BRUCITE.

[In honor of the late Dr. ARCHIBALD BRUCE, of New-York.]

Brucite. *Beudant.* — Hydrate of Magnesia. *Cleaveland, Phillips, Thomson* and *Shepard.* — Native Magnesia. *Bruce.* — Prismatic Talc-Mica, var. *Jameson.*

DESCRIPTION. Colour white, inclining to green, and also grey. Streak white. It occurs in plates which have a lamellar structure, and sometimes in prismatic concretions that point to the regular six-sided prism. It is easily split into thin flexible laminæ. Lustre shining, and somewhat pearly. Semi-transparent in the mass, and transparent in single folia. Hardness 1.0 to 1.5. Gives on paper a polished pearly trace. Specific gravity 2.35. Before the blowpipe, it gives out water, but is not fusible. By the oxyhydrogen blowpipe, however, small portions of it may be fused into an enamel. It is soluble without effervescence, in dilute muriatic, nitric, and sulphuric acids.

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* *Brewster's Edinburgh Journal of Science.* III. 309. This volume also contains the paper of Mr. Haidinger, from which the above extract is made.

Composition. Magnesia 68.34, water 30.90, protoxide of manganese 0.64, protoxide of iron 0.12 (*Stromeyer*). It is undoubtedly a compound of one atom of water and one of magnesia. Formula Mg + Aq.

Geological Situation. This mineral has heretofore been found in veins traversing serpentine. It is usually accompanied by other magnesian minerals.

LOCALITIES.

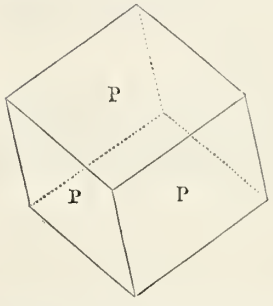
Richmond County. Hydrate of magnesia occurs associated with talc and carbonate of magnesia in the serpentine rock which forms the principal range of hills on the island. It has been found in small specimens at the Quarantine. The first discovery of it in the United States was at Hoboken, New-Jersey, where it is still obtained. By long exposure to the atmosphere, it is converted into the carbonate of magnesia.

Westchester County. This mineral is found associated with serpentine on the peninsula east of New-Rochelle. It also occurs in a similar formation two miles north of the village of Rye. It is in the form of small imperfect crystals or plates having a pearly lustre, and is often invested with powdery carbonate of magnesia, undoubtedly formed by the action of the atmosphere upon the hydrate.

CARBONATE OF MAGNESIA.

Carbonate of Magnesia. *Cleaveland*, *Phillips* and *Thomson*. — Dolomite, or Macrotopous Limestone. *Jameson*. — Magnesite. *Shepard*. — Giobertite. *Beudant*.

Fig. 123.



Description. Colour white or yellowish white. It occurs in delicate acicular crystals, or in a white powder; also in dull opaque masses, with a flat conchoidal or earthy fracture. The primary form is said to be a rhombohedron. P on P 107° 25′ and 82° 35′ (*Beudant*). Hardness sometimes about 3.5. Specific gravity from 2.56 to 2.88. Before the blowpipe, on charcoal, it shrinks a little, and then acts on vegetable blues like magnesia; with borax or biphosphate of soda, it fuses into a glass. It dissolves slowly, and with little effervescence, in cold nitric acid; but more readily when heat is applied, especially if it is reduced to a fine powder. The solution thus obtained is scarcely precipitated by oxalate of ammonia, but copiously by a solution of potash.

I include under this name the minerals which are principally composed of carbonate of magnesia, and which occur in needle-form crystals, or in a white powder coating the hydrate of magnesia. When in the latter form, it is probably the same as the hydro-carbonate of magnesia described by Dr. Thomson as from Hoboken in New-Jersey, and which is similar in appearance to the *magnesia alba* of the shops. The *Giobertite* of Beudant is a nearly pure carbonate of magnesia, which occurs in the magnesian rocks of Piedmont, the Tyrol, &c.

Composition. *Hydrocarbonate of Magnesia from Hoboken, N. J.*—Carbonic acid 36.82, magnesia 42.41, oxide of iron 0.27, water 18.53, silica 0.57 (*Wachtmeister*).

Giobertite from Baumgarten—Carbonic acid 50.75, magnesia 47.63, oxide of manganese 0.21, water 1.40 (*Stromeyer*).

The *Magnesian Marble* of Nuttall, referred to this species by Dr. Thomson, belongs to Dolomite; and the Magnesite, often also placed with it, is a silicate of magnesia, and is more nearly allied to serpentine than to carbonate of magnesia. The water, oxide of iron, oxide of manganese and silica in the preceding analyses, are probably accidental ingredients.

Geological Situation. This mineral, I believe, invariably accompanies magnesian rocks, and in our localities it is always associated with some of the varieties of serpentine.

LOCALITIES.

Richmond County. Crystallized carbonate of magnesia has been found in veins and in cavities in serpentine or steatite. The crystals are delicately acicular, diverging or radiating in groups, white and possessing a satiny lustre. It is also found in flesh-coloured crusts not more than two lines thick, having a foliated or sparry structure. It is totally soluble in sulphuric acid.

The pulverulent variety is also found in various parts of this serpentine range, although it is seldom so abundant as at Hoboken in New-Jersey, where similar magnesian minerals occur. In the purest specimens of this powder which I have obtained, there were portions of silica, alumina, and a little oxide of iron. The proportion of water is very variable. It is probably mixed with serpentine or magnesite.

The occurrence of carbonate of magnesia on Staten island, was first noticed by James Pierce, Esq.*

Westchester County. Carbonate of magnesia, both compact and imperfectly crystallized, is found associated with serpentine on the peninsula east of New-Rochelle.

Two miles north of Rye, it is in the form of a white powder, and in concreted masses in veins associated with magnesite or serpentine. In this case, the carbonate is probably the result of the action of air upon the hydrate of magnesia, which is also found with the above named minerals.

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* *American Journal of Science.* I. 142.

EPSOM SALT.

[From its having first been found at *Epsom*, in England.]

Magnesie Sulfatée. *Haüy.* — Sulphate of Magnesia. *Cleaveland, Phillips* and *Thomson.* — Prismatic Epsom Salt. *Jameson.* — Prismatisches Bitter-Salz. *Mohs.* — Epsomite. *Beudant.*

Description. Colour white and grey. It occurs regularly crystallized; also in crusts, botryoidal and reniform. The primary form is a right rhombic prism nearly rectangular. Fig. 124. M on M′ 90° 30′. Fig. 125 is one of the secondary forms, the *pyramidée* of Haüy. M on *l* 129° 14′; *l* on *l* 126° 52′. Cleavage perfect parallel to the shorter diagonal of the primary. Fracture conchoidal. Lustre vitreous. Transparent or translucent. Very brittle. Hardness from 2.0 to 2.5. Specific gravity from 1.66 to 1.75. Before the blowpipe on charcoal, it is converted into sulphuret of magnesium. It dissolves in an equal weight of cold water. Taste bitter. The solution gives with potash a white pulverulent precipitate, which becomes lilac when it is heated upon charcoal, after the addition of a drop of nitrate of cobalt.

Fig. 124.

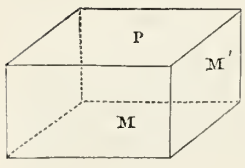
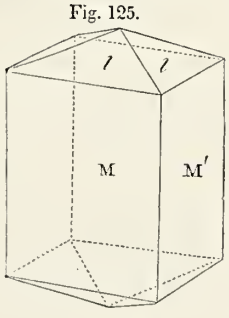


Fig. 125.



Composition. Magnesia 16.0, sulphuric acid 32.53, water 51.43. $MgO.SO_3+7Aq$.

Geological Situation. It occurs in alum mines, and in several mineral waters. In this State, it is almost always found as an efflorescence on limestone rocks.

LOCALITIES.

Albany County. Epsom salt, in the form of efflorescences, has been observed in a side-hill near Coeymans landing. On the east face of the Helderberg, in the town of Bethlehem, near Mr. Fryer's, it is found in needleform crystals and in crusts on the surface of an impure water limestone. It is also found in the town of Guilderland.

Cayuga County. Epsom salt occurs in the eastern ledge of rocks near the head of Cayuga lake, for three or four miles, in connexion with sulphate of iron and thin layers of coal. It is also found at the base of a hill on the east bank of Owasco creek, near Auburn. The same mineral occurs on the slate near Ludlowville. Specimens of the latter, received from Mr. Vanuxem, were found on analysis to be nearly pure.

It may be here remarked, that Mr. Vanuxem ascribes the columnar form of some of the limestones at the west to the crystallization of the sulphate of magnesia in fibrous crystals at the joints of the rock. The carbon which invests the striæ was a subsequent action, probably a deposition from the same water which dissolved the mineral.*

* Vanuxem. *New-York Geological Reports*, 1838.

Columbia County. This mineral has been found in efflorescences on the slate near the city of Hudson, and it is similarly found in the vicinity of Buffalo in Erie county.

Essex County. Efflorescences of epsom salt and sulphate of lime form in dry weather on the banks of clay in the neighborhood of Crown-Point, and it may be collected in a pure state. Some wells in Addison, Vermont, in the same clay, are so highly charged with this salt, that they cannot be used except as reservoirs of rain water. A portion of saline water taken from the spring near Crown-Point, had a specific gravity of 1.014. 1000 parts by weight contain 18.78 saline matter, the greater part of which is sulphate of magnesia, with some sulphate of lime.*

Monroe County. Efflorescences similar to those already described, are found on the limestone and shale below the Genesee falls, near the city of Rochester. It is here, however, usually mixed with common salt and a little sulphate of soda.

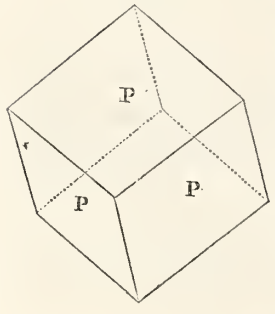
Oneida County. Some localities of epsom salt have been noticed in this county.

Rensselaer County. Three miles above Lansingburgh, on the Hudson river, it occurs in efflorescences on clay. After a long drought, the whole face of the bank is often nearly covered with the salt. The marly clay which forms the bank contains magnesia and iron pyrites, the latter in very minute grains and in variable proportions.†

MAGNESIAN CARBONATE OF LIME.

Magnesian Carbonate of Lime. *Cleaveland.* — Chaux Carbonatée Ferrifère Perlée, and Chaux Carbonatée Magnesifère. *Haüy.* — Calcareo-Carbonate of Magnesia. *Thomson.* — Bitter Spar. *Phillips.* — Dolomite, or Macrotypous Limestone. *Jameson.* — Makrotypes Kalk-Haloid. *Mohs.* — Gurhofian. *Klaproth,* and *Mohs, App.* — Dolomite. *Shepard* and *Dana.*

Fig. 126.



Description. Colour white, generally inclining to red or green, red, brown, grey and black, owing to foreign admixtures. Streak greenish white. It occurs regularly crystallized; also massive and disseminated. The primary form is a rhombohedron. Fig. 126. P on P 106° 15′. Cleavage parallel with the primary rhombohedron. Fracture splintery, conchoidal and slaty. Lustre vitreous, inclining to pearly in some varieties. Varies from transparent to translucent on the edges. Brittle and easily frangible. Hardness from 3.5 to 4.0. Specific gravity from 2.81 to 2.88.

Before the blowpipe, this mineral is scarcely distinguishable from calcareous spar. Some varieties, however, become harder and assume a darker colour. It dissolves slowly and without much effervescence in acids, by which it may in general be distinguished from carbonate of lime.

Varieties. *Miemite.* This has a greenish white or green colour. Internally it is splendent and pearly. Fracture foliated and curved. It occurs crystallized and massive.

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* Emmons. *New-York Geological Reports,* 1838. † Eaton. *American Journal of Science.* XV. 242.

Pearl Spar—Chaux Carbonatée Ferro-magnesifère of Haüy. Occurs in obtuse rhombohedrons with curved faces. It is white, reddish white, red, brown and pearl grey; has generally a pearly lustre; is translucent, and rather harder than calcareous spar.

Brown Spar. This name has sometimes been applied to those varieties which have a reddish brown colour, and do not exhibit curved faces.

Dolomite. This occurs massive, and sometimes has a slaty structure. It is made up of small granular concretions, which are sometimes so loosely aggregated as to separate by the mere pressure of the fingers. The colour is usually white, but it sometimes has a tinge of blue or grey. The *magnesian limestone* of England is a dolomite with yellow or yellowish brown colours.

Gurhofian, or *Gurhofite.* A name which was given to a variety found near Gurhof in Lower Austria. It has a snow-white colour, and is very compact; the fragments, which are sharp, are translucent on the edges. Fracture flat, conchoidal.

Composition. This mineral is composed of the carbonates of lime and magnesia, with minute quantities of oxide of iron, manganese, etc. The proportions of the principal ingredients, however, are liable to some variation. In eight analyses by Berthier, the proportion of lime is from 10.7 to 44.0 per cent.; that of magnesia, from 7.7 to 22.4; of carbonic acid, from 18.6 to 47.0. The protoxides of iron and manganese, when present, do not exceed 1.8 per cent.

Compact Dolomite—Carbonate of lime 59.40, carbonate of magnesia 39.70, peroxide of iron 0.9 (*Beudant*).

Rhombohedral Dolomite—Carbonate of lime 68.00, carbonate of magnesia 25.50, carbonate of iron 1.00, water 2.00, argil 2.00 (*Klaproth*).

Gurhofite—Carbonate of lime 70.50, carbonate of magnesia 29.50 (*Klaproth*).

Geological Situation. The white granular or saccharoid variety is found in beds in primary rocks; the crystallized and cleavable varieties occur in transition and secondary limestones. In New-York, the latter are principally met with in calciferous sandstone, in the Lockport limestone and in the Hudson river slate.

LOCALITIES.

Columbia County. The variety called *Brown Spar*, occurs somewhat abundantly in a narrow range in this county. It is associated with quartz in the slate. It seems here to contain an unusually large proportion of oxide of manganese; and by its decomposition, it gives rise, as Mr. Mather thinks, to the occurrence of *Wad*, which is here quite common.*

Dutchess County. The variety dolomite is found in vast beds in the towns of Amenia, Dover, Pawlings, Beekman and Fishkill (see page 68).

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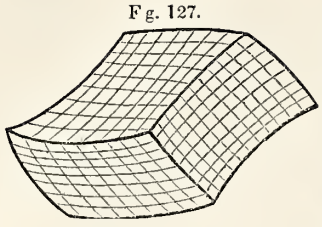
* *New-York Geological Reports*, 1838.

Fig. 127.



Herkimer County. Brown and pearl spar, in white and pearly crystals, are found in geodes in the calciferous sandstone at Little-Falls, Middleville, &c. They are associated with crystallized quartz and anthracite. The pearl spar has the crystals much bent, as in Fig. 127.

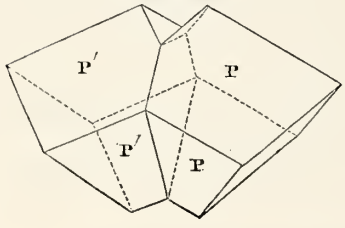
Monroe County. In the limestone at Rochester and elsewhere in this county, fine specimens of pearl spar have been obtained. The accompanying minerals are calcareous spar, snowy gypsum, and rarely fluor spar, celestine and zinc blende.

Montgomery County. Brown or pearl spar is found with galena and calcareous spar, in a vein in slate in the town of Root.

New-York County. At Kingsbridge, dolomite occurs large grained, and sometimes with indications of a foliated structure. It has been extensively used as a building material, and for burning into lime. It is similar to the marble found in Westchester county.

Niagara County. Pearl spar, associated with calcareous spar, selenite, sulphate of strontian, and rarely with fluor spar and zinc blende, is found in the fetid limestone at Lockport, Niagara falls, and elsewhere in this county. At Lockport, where there are immense numbers of superb geodes of various sizes, the crystals are of a white colour, and sometimes with a delicate pink tinge. They are rhombohedrons, and have their surfaces much curved as in Fig. 127, with a high pearly lustre. The specimens at Niagara falls are of a similar form, but are much less beautiful than those of Lockport. The twin crystals, Fig. 128, occur at both these localities.

Fig. 128.



A specimen of pearl spar from Lockport, which I analyzed, contained

Carbonate of lime,	59.00
Carbonate of magnesia,	39.50
Carbonate of iron,	1.50

Oneida County. There is a locality of brown spar at Clinton, near the College; but it is not of much interest.

Orange County. The limestone in the village of Warwick affords good specimens of brown spar. This variety is also found a mile southeast of that village, and at Hampton, six miles northeast of Newburgh. It also occurs at the Wilks mine in Monroe.

Putnam County. The variety dolomite abounds in various parts of this county. On Hustis' farm in Phillipstown, there is a stratum of the variety gurhofite. It is sometimes snow-white, very fine grained and compact; has a semi-opaline appearance, and a fracture resembling porcelain. Its composition, according to my analysis, is as follows:

Carbonate of lime,	66.75
Carbonate of magnesia,	26.50
Silica,	6.75

Other specimens have fibres of asbestus running through them, and they sometimes have a bluish tint, and contain crystals of bronze-yellow iron pyrites. These specimens resemble the picrolite. When dissolved in muriatic acid, there is usually a portion of silica unacted on, probably from the serpentine which is mechanically mixed with it.

Richmond County. A mineral closely resembling the gurhofite is found in a stratum at the Quarantine. It is white, compact, has a flat conchoidal fracture, and is so hard as sometimes to strike fire with steel. It is exceedingly tough and difficult of solution, except when in very fine powder. Specific gravity 2.712. An analysis of a specimen obtained near the Pavilion at the Quarantine, gave the following results, viz:

Carbonate of lime,	52.75
Carbonate of magnesia,	42.25
Insoluble matter, chiefly silica,	5.00
Oxide of iron,	traces.

It differs from the hard carbonate of magnesia found at Hoboken in New-Jersey.

Dolomite, in the form of imperfect and variously aggregated rhombohedral crystals, is also found near the locality of the preceding variety. It is of a bluish white colour, and is found in a vein associated with a dark coloured argillaceous substance apparently the result of decomposition.

St. Lawrence County. Four miles from Hammond, there is a ledge of dolomite, or coarsely granular magnesian limestone. It is greyish white, and contains small plates of yellow mica and particles of graphite.*

Brown spar of a yellowish brown colour, and closely resembling that from Hoboken, N. J., is found in nodules in limestone near Gouverneur.

At the Parish ore bed there are found curved crystals of brown or pearl spar, which pass into carbonate of iron. They are usually small, and are associated with calcareous and heavy spar.

Warren County. At Glen's-Falls, rhomb spar is found in well defined glistening crystals, in the dark coloured limestone. Pearl spar also occurs in minute white and curved crystals, with calcareous spar and crystallized quartz, in the calciferous sandstone on Diamond island, and at Diamond point, Lake George. The compound form Fig. 128, is quite common. The geodes which contain these crystals are abundant, but seldom large.

Westchester County. The granular dolomite, commonly called *white marble*, is abundantly diffused. Quarries have been opened at Hastings, Sing-Sing, Eastchester, &c., and have long been profitably worked. For a more detailed description of these marbles, the reader is referred to page 71.

The rounded masses called *septaria*, and which are found in the counties of Schoharie,

* J. Finch. *American Journal of Science.* XIX. 220.

Cayuga and Chautauque, often contain, in the seams which run through them, minute crystals of dark coloured pearl spar.

HYDRAULIC LIMESTONE.

This substance, as found in the State of New-York, is almost always a compound of carbonates of lime and magnesia, together with variable proportions of clay or silicate of alumina. For a full description and notices of our localities, the reader is referred to page 75 of this work.

HYDROBROMATE OF MAGNESIA.

Bromide of Magnesium, *of Chemists.*

This salt, which has heretofore been found only in very minute quantity in sea water and in the water of certain springs, occurs in acicular prisms, very soluble in water and alcohol. It is bitter, and very deliquescent. The pure bromide, when exposed to heat, or to the air, is said to be resolved into magnesia and hydrobromic acid. Formula MgBr.

CLASS VI.

EARTHY MINERALS.

Composed chiefly or in part of one or more of the earths proper; they frequently contain some alkali or alkaline earth, acid or metallic oxide.

ORDER I. SILICA.

I. *Minerals in which the silica is nearly pure.*

1. Quartz, and its varieties.

II. *Minerals in which the silica plays the part of acid.*

2. Tabular Spar.
3. Nemalite.
4. Serpentine.
5. Magnesite.
6. Chondrodite.
7. Boltonite.
8. Talc.
9. Pyroxene.
10. Hornblende.
11. Arfwedsonite.
12. Hypersthene.
13. Schiller Spar.
14. Anthophyllite.
15. Hydrous Anthophyllite.

QUARTZ.

Quartz. *Cleaveland.* — Quartz, Calcedony, Jasper and Hornstone. *Phillips.* — Quarz. *Haüy* and *Beudant.* — Rhombohedral Quartz. *Jameson.* — Rhomboedrischer Quarz. *Mohs.*

Fig. 129.

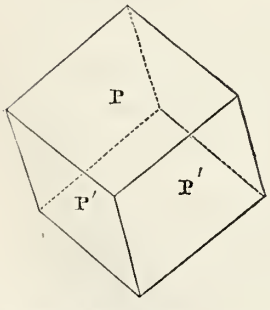
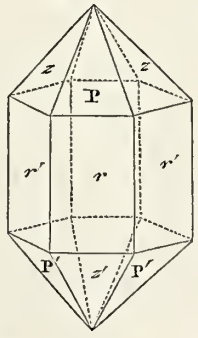


Fig. 130.



Description. Colour white, grey, less frequently black, blue, green, yellow, red and brown. It occurs regularly crystallized; also massive, disseminated in plates, stalactitic, reniform, botryoidal, globular, specular, vesicular and cellular. Primary form an obtuse rhombohedron. Fig. 129. P′ on P′ 94° 24′ (*Haüy*); 94° 15′ (*Phillips*). The common form is a six-sided prism terminated by six-sided pyramids, *prismé* of Haüy. Fig. 130. P on r, P′ on r', r on z', or r' on z 141° 40′; r on r' 120°. Fracture

conchoidal, even, uneven and splintery. Lustre splendent and vitreous in the crystallized specimens; sometimes inclining to resinous, and sometimes only shining or glimmering. Varies from transparent to opaque. Brittle and easily frangible. Hardness 7.0. Specific gravity from 2.50 to 2.70. Before the blowpipe alone it is infusible; but with carbonate of soda, it fuses with brisk effervescence into a transparent glass.

Varieties. *Rock Crystal.* This includes the transparent and highly crystallized varieties. It sometimes presents beautiful iridescences, both superficially and internally. Sometimes also it encloses foreign substances, as anthracite, bitumen, titanite, oxide of iron, etc.

Amethyst. This name is applied to the pyramidal translucent and transparent varieties, which have a violet blue tint. It becomes white and opalescent by long exposure to heat.

Milk Quartz and *Rose Quartz.* These occur massive, and are only distinguished by their colour; the former presents a milky aspect, while the latter has frequently a fine rose-red colour, which is supposed to be derived from a minute admixture of manganese.

Common Quartz. This includes those varieties which are of a grey or white colour, with a low degree of translucency, and occur massive and disseminated.

Prase. This has a leek-green colour, a resino-vitreous lustre, and a conchoido-splintery fracture.

Yellow and *Brown Quartz.* These are of various shades of yellow and brown, and more or less translucent or transparent.

Iron Flint or *Ferruginous Quartz*, presents various shades of yellow and red, and occurs both massive and crystallized. It is opaque.

Radiated Quartz, occurs in crystals which are closely aggregated, and which radiate from a point.

Fibrous Quartz. This is produced when the composition presents thin columnar particles. The *Cat's-eye* is a variety of this, interspersed with thin filaments of asbestus, which, when the stone is cut, present a peculiar opalescent appearance. It is usually of a greyish or greenish colour, but sometimes brown or red.

Hornstone, includes those varieties with dull colours, which occur massive and in extraneous external shapes, with a splintery or conchoidal fracture, dull and glimmering lustre, and which are opaque or translucent only on the edges.

Hyalite—Muller's Glass. This occurs in white and transparent botryoidal masses, or in stalactites. It has a vitreous lustre, is brittle, but is as hard as quartz.

Flint. This has a grey, brown or black colour; generally occurs massive, and in various imitative forms; has a glimmering lustre, conchoidal fracture and feeble translucency.

Calcedony. The semi-transparent and translucent varieties, in massive and various particular external forms, with an even and dull fracture.

Chrysoprase. This includes the beautiful apple-green, strongly translucent varieties.

Carnelian. The semi-transparent and strongly translucent varieties, with glistening or shining vitreous lustre, and with various tints of red, brown, yellow, green and white.

Jasper. Those varieties in which the colours are red, brown and black, and sometimes

yellow or green, which occur massive and disseminated, with a fracture varying from conchoidal to earthy, and a lustre from glistening to dull. They are opaque.

Spongiform Quartz, or *Floatstone*. It has a spongy or porous appearance, and consists of numerous white or greyish white crystals. It is so porous and light as to swim on water, whence its name.

Siliceous Sinter. This is white, greyish white and yellow. It is light and brittle, dull, commonly porous, with a fibrous texture, although sometimes sufficiently compact to admit of a conchoidal fracture. Lustre pearly.

Composition. *Rock crystal* — Silica 99.37 (*Bucholz*).

Amethyst — Silica 97.50, alumina 0.25, oxide of iron a trace, manganese 0.75 (*Rose*).

Common Quartz — Silica 97.75, alumina 0.50, water 1.00 (*Bucholz*).

Red Iron Flint — Silica 76.8, alumina 0.25, oxide of iron 21.66, volatile matter 1.00 (*Bucholz*).

Carnelian — Silica 94.00, alumina 3.50, oxide of iron 0.75 (*Bindheim*).

Chrysoprase — Silica 96.17, alumina 0.08, lime 0.82 (*Klaproth*).

Common Flinty Slate — Silica 51.84, alumina 15.43, lime 9.42, oxide of iron 9.96 (*Dumeril*).

Geological Situation. This mineral is very widely distributed, and is one of the most abundant in nature. It is found in almost every formation. In the State of New-York, the finest crystalline varieties are obtained in the sandstone, slate, and calciferous sandrock.

LOCALITIES.

As quartz is so extensively diffused, I shall notice only the more important localities of those varieties which are usually esteemed as mineralogical specimens. In this respect, our State is peculiarly rich, and probably no part of the world affords more beautiful or more interesting crystalline forms.

Albany County. In the fissures of slate in this county, transparent crystals have been found. The most noted locality is Crystal hill, about three miles below the city.

On the Helderberg, about sixteen miles from the city, druses of quartz crystals are found in the limestone, of a dull yellowish colour. They were called *ferruginous quartz*, but they do not belong to that variety. Hornstone is also common in this rock.

Columbia County. I have only to remark here, that at Chatham, there is an amorphous mass of quartz, more than an hundred feet in diameter, with hexahedral crystals disseminated.*

Essex County. Crystallized quartz is found in various parts of this county, but I am not acquainted with any locality at which the specimens are remarkable for their beauty.

Rose quartz, of a very rich and beautiful colour, is found in the vicinity of Port Henry.

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* Eaton. *Cleaveland's Mineralogy.*

Greene County. Rock crystal is often found in seams and veins in the slate in various parts of this county. The best locality, however, at present known, is at Diamond hill, in the village. The quartz is imbedded in a stiff clay, between layers of the slate. A great variety of crystalline forms have been found at this place. Crystals are said to have been here obtained, weighing two or three pounds. They sometimes had cavities containing a liquid, a bubble of air, and some black or brown particles. In one specimen the cavity was five-eighths of an inch long and a quarter of an inch wide, the bubble occupying nearly half the cavity.*

The specimens recently found at this locality will not by any means compare in beauty with those which have been obtained in Herkimer county, but many of them present very interesting modifications. They are seldom limpid throughout, and a large majority of the specimens are imperfect. They seem, however, to be still abundant in the clay-filled cavities of the slate. The forms which I have observed here, are those represented as follows, viz :

Fig. 130, *prismé* of Haüy (p. 257.)

The *rhombifère* of Haüy, similar to the preceding, with the addition of the rhomboidal truncations of the alternate, lateral solid angles. Fig. 131. P on *s*, or *z* on *s* 151° 7′; *r* on *s*, or *r*′ on *s* 142°.

The same as Fig. 130, but having two opposite sides of the prism and the adjacent pyramidal faces unduly extended: *prismé comprimé* of Haüy, Fig. 132.

Prismé sphalloïde of Haüy, Fig. 133.

Fig. 131.

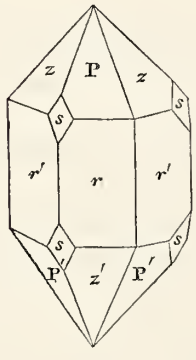


Fig. 132.

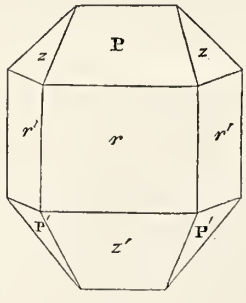
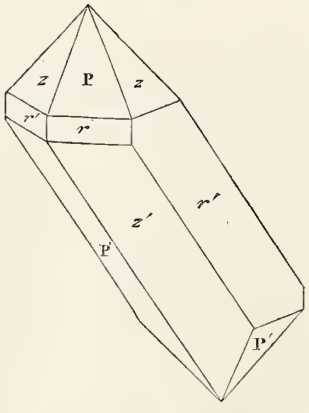


Fig. 133.



* *Cleaveland's Mineralogy.*

Also the forms represented in Figures 134, 135, 136, 137, 138, and the twins 139 and 140. These crystals are usually small.

Fig. 134. Fig. 135. Fig. 136. Fig. 137. Fig. 138.

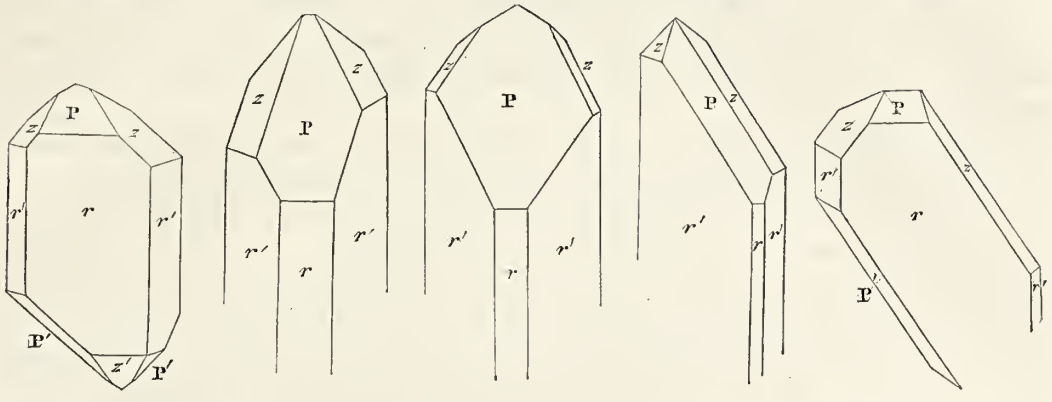
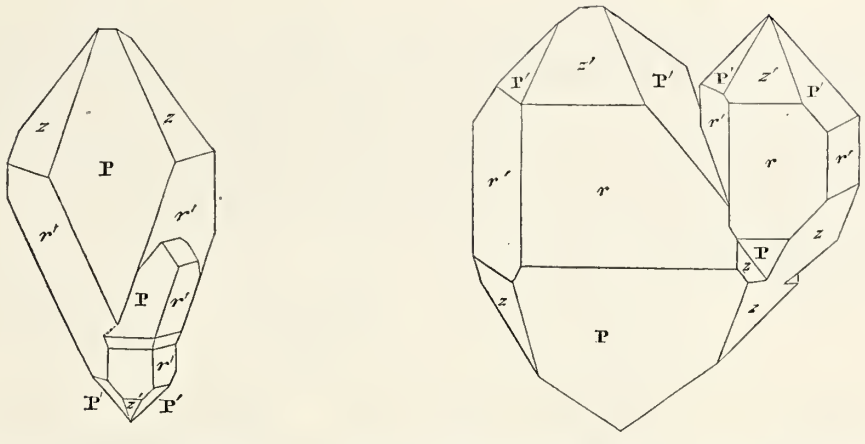


Fig. 139. Fig. 140.



Similar crystals are obtained in the slate near the paper mill, two miles west of Catskill; and during the process of excavations that were made for the railroad, large and beautiful crystals were sometimes thrown out.

Herkimer County. Uncommonly beautiful specimens of rock crystal, perfectly transparent, have been found in various parts of this county, especially at Middleville, Fairfield, Little-Falls, Salisbury and Newport. They are found sometimes in cavities in the calciferous sandstone; and at others, they lie loosely in the sand, probably produced by the disintegration of the rock. Mr. Vanuxem has remarked, that there is probably no locality in the world which produces more perfect or more beautiful quartz crystals than Middleville; and with an equal refractive power, they would rival the diamond. They are found of various sizes, and variously grouped. Perfect crystals have seldom been found here of more than two or three inches in length, while those of from three quarters of an inch to an inch are very abundant.

They frequently contain specks and small masses of a black substance, which is believed to be anthracite. Its behaviour before the blowpipe agrees entirely with that mineral. Sometimes these crystals have cavities, which are partly filled with some fluid. When these have been shivered by the cold, the cavities present a yellow resinous appearance, from which it may be inferred that the liquid is bituminous. From the number of fragments which present this appearance, it is probable that the crystals containing this liquid were originally very abundant.

At Little-Falls, the quartz crystals are usually contained in cavities in the calciferous sandstone, and it is not uncommon to find them imbedded in the powder of the anthracite.

The crystals from Salisbury are larger than those from any other locality in the county, but they have seldom been obtained so perfect as at Middleville. Here also large masses of anthracite were found associated with the quartz. The crystals from this locality are sometimes from four to six inches in length.

At all the above localities, twin crystals, and groups of crystals variously united, have been found. Middleville, however, is the most remarkable in this respect. Crystals of quartz, usually small, are also often found lining the walls of the cavities which contain the loose crystals.

It is proper to state, that the occurrence of quartz crystals in such abundance in this county was first made known to the public by Prof. J. Hadley, of the Geneva Medical College.*

Among the vast number of crystals which have been obtained in this county, it is not surprising that various and rare forms sometimes occur. From some hundreds which I have examined, the following are selected as more or less interesting, viz :

Figs. 130, 131, 132, 133, already introduced ; and Figs. 141, 142, 143, 144, 145, 146, 147, and the twin 148, from Little-Falls.

Fig. 141.

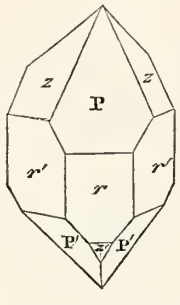


Fig. 142.

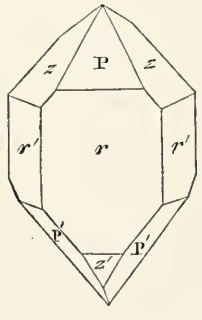


Fig. 143.

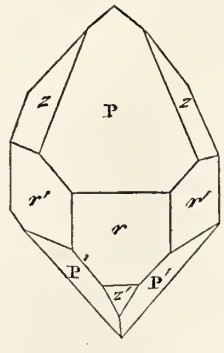
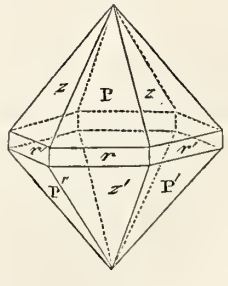


Fig. 144.



* *New-York Medical and Physical Journal.* II. 132.

Fig. 145.

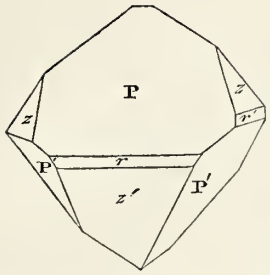


Fig. 146.

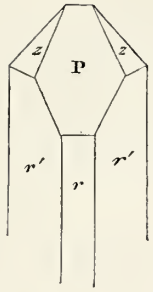


Fig. 147.

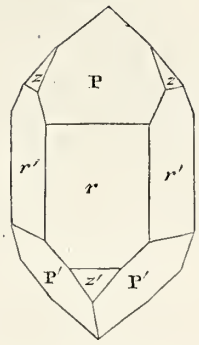
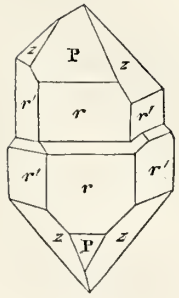


Fig. 148.



Figs. 130, 131, 132, 133, 136, 141, 142, 144, 147, 148; together with Figs. 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160*, and also the twins 140 and 161, from Middleville.

Fig. 149.

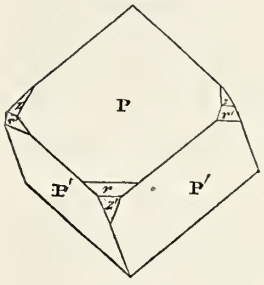


Fig. 150.

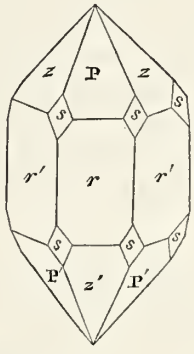


Fig. 151.

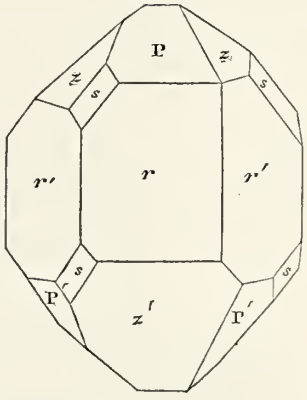


Fig. 152.

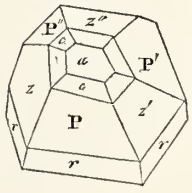


Fig. 153.

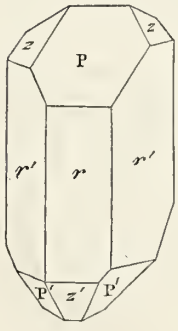


Fig. 154.

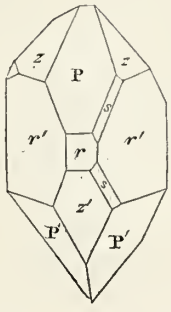


Fig. 155.

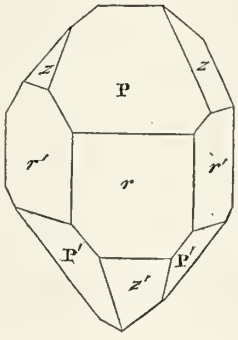
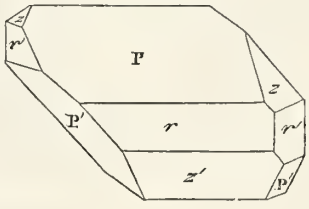


Fig. 156.



* Figures 157, 158, 159 and 160, are introduced on the authority of Dr. Horton.

Fig. 157. Fig. 158. Fig. 159. Fig. 160. Fig. 161.

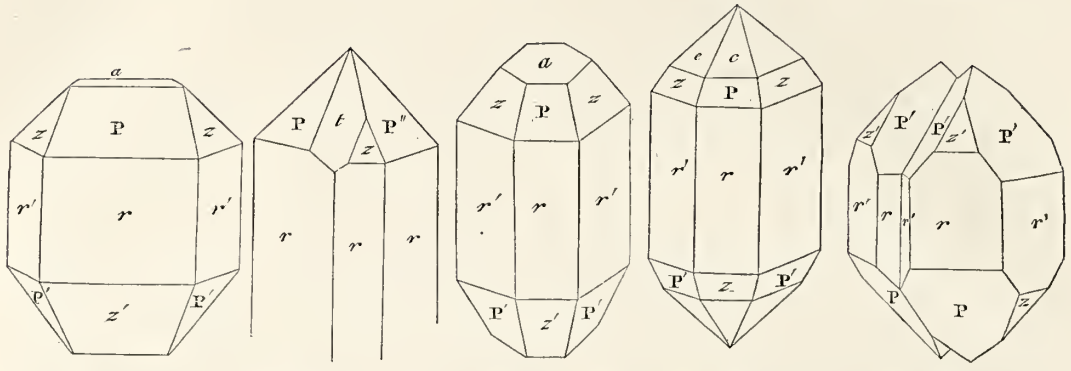
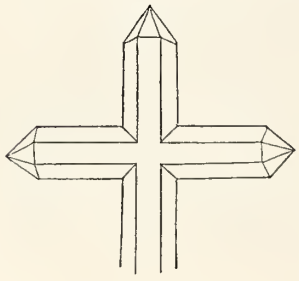


Fig. 152. P on *a* 145° 22′; *c* on *a* 159° 50′; *c* on P 165° 30′; *z″* on *a* 111° 15′; *z* on *a* 137° 51′; *z* on *e* 145° 30′; *a* on *e* 175° 30′ (*Shepard*).

Figs. 157, 158, 159, 160. P on *a* 145° 22′; P on *t* 154°; P″ on *t* 103° 50′; *t* on *z* 155°; *r* on *t* 133° 50′; *z* on *a* 137° 51′; P on *c* 165°; *e* on *z* 145° (*Horton*).

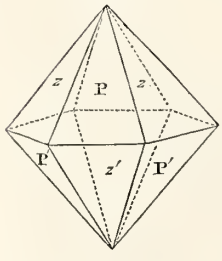
Fig. 161 (*bis*).



Jefferson County. On the banks of Vrooman lake, in the vicinity of the village of Oxbow, crystallized quartz is found in cavities and geodes, associated with crystallized calcareous spar. The crystals are small, usually regular six-sided prisms with six-sided pyramids. These sometimes cross each other at right angles, as in the accompanying Fig. 161 (*bis*). They are translucent and transparent, and occasionally have a yellowish tint.

In the same town (Antwerp), at the Sterling ore bed, crystallized quartz is associated with the specular iron, and is often coated with the rare *Cacoxenite*. These crystals, which are usually limpid, but are occasionally tinged by oxide of iron, have the prisms very short, as in Fig. 144; or entirely wanting, forming the *dodécaèdre* of Haüy, Fig. 162. They are similar to those which occur in St. Lawrence county, but are smaller.

Fig. 162.



It is a curious fact, that the cavities in which these crystals occur, often contain pure water or a colourless liquid. The same thing, however, has been observed in regard to geodes of quartz and other crystals at various localities, both American and foreign.*

* See *Brewster's Edinburgh Journal of Science.* X. 24 and 28.

Fig. 163.

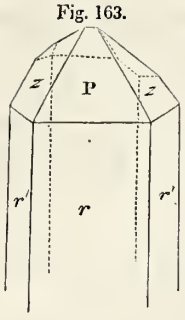
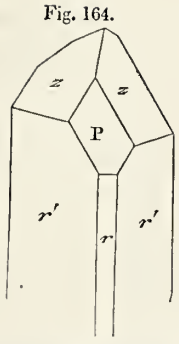


Fig. 164.



Lewis County. Near Natural bridge, in the town of Diana, large opaque or semi-transparent crystals occur, with one or both terminations perfect, in a vein in the sandstone. In addition to several common forms, those represented in Figs. 163 and 164 have been noticed at this locality. About a mile and a half north of Natural bridge, drusy quartz occurs abundantly in geodes in the sandstone. The colours are white, reddish and bluish white.

Monroe County. Small masses of hornstone, sometimes resembling calcedony, have been found in the vicinity of the city of Rochester.

Montgomery County. At Palatine, quartz crystals occur, having one end terminated by a regular hexahedral pyramid, while the other is globular and smooth as if fused.

Near Spraker's basin, both in the towns of Root and Palatine, druses of quartz crystals of considerable beauty are found, associated with calcareous spar, in the calciferous sandstone. Masses of aggregated crystals are sometimes found coloured with oxide of iron, and which may be called *ferruginous quartz*. Hornstone and coarse agate are also abundant.

New-York County. I am not aware that crystallized quartz is met with in any quantity. Inferior specimens are occasionally found in the gneiss. Dr. Gale refers to a locality in the Harlem railroad cut, about 122d-street.* Rolled masses of jasper, usually red, but sometimes brown, as well as the striped variety, have been found on various parts of the island with hornstone. Near Kingsbridge, the quartz is sometimes fetid.

Ontario County. According to Mr. Hall, small geodes, lined with calcedony, occur in the sandstone at Vienna, on Flint creek.†

Orange County. The slate in this county sometimes embraces beds of quartz. Some of them may be seen on a cross-road from Bellvale to Thomson's pond. In dip and direction, they coincide with the slate in which they are embraced. Some of them are from ten to twenty feet in width. The quartz of these deposits is granular, columnar and crystallized. The crystals, however, are not usually perfect.‡

Four miles east of the village of Warwick, the primary form (Fig. 129) occurs in cavities in jasper. The crystals are small, but very perfect. At this locality, also, are found specimens of calcedony coating cavities in the jasper.

At Rocky hill, in the town of Warwick, there are found crystals which vary from translucent to opaque, of a reddish and yellowish white colour, and which resemble *Haytorite*. But the specimens which I have seen, although unlike any of the crystalline quartz with which I am acquainted, are too imperfect for accurate measurement.

Crystals similar to those represented in Figs. 130 and 131, have been found near Craigville; and those similar to Fig. 132, both blue and white, occur in Warwick.

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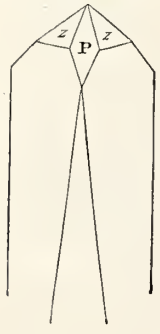
* *New-York Geological Reports*, 1839. † Ibid. ‡ Horton. Ibid.

The variety *Heliotrope* is found in veins in the slate in the town of Bloomingrove. It is of a rich grass-green colour, finely translucent, and is susceptible of a fine polish.

In the town of Monroe, two and a half miles southeast of Greenwood furnace, there is a bed of quartz. At the northeast end, where alone it is visible, it is four rods wide, and rises fifteen feet above the gneiss on each side. It is visible for more than twenty rods, and gradually disappears beneath the surface. The quartz is white and nearly opaque, containing in many places green coccolite.*

Putnam County. Hyalite, of a light blue colour, is found in thin coatings on the granite at the Phillips ore bed. It is rare, and is sometimes associated with green malachite.

Fig. 165.



Rensselaer County. Diamond rock, near the village of Lansingburgh, has furnished fine specimens of limpid quartz. Some were well defined and doubly terminated, but most commonly one of the ends was imbedded in the rock. The forms observed here are those represented in Figs. 131 and 132. It is now exceedingly difficult to obtain good specimens from this locality, but crystals of various degrees of perfection are not uncommon in the slate in various parts of the county. The form represented in Fig. 165, is common at Williamstown, and may hereafter be found in this and in Columbia county.

Richmond County. Smoky quartz, as well as the limpid variety, occurs in well defined crystals in the hill which passes through this county. It is usually in druses of small crystals, and sometimes these radiate from a centre, and exhibit perfect terminations on the circumference. The specimens are often so deeply coloured as to place them under the ferruginous variety.

The walls of the thin fissures in the greenstone at Port Richmond quarry, are sometimes studded with small but quite perfect crystals of quartz, associated with equally minute crystals of feldspar.

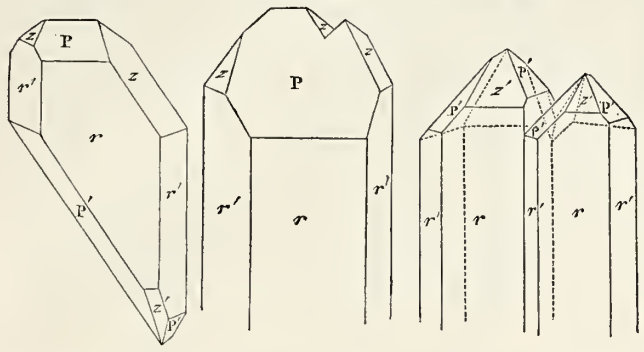
St. Lawrence County. At the mines of specular iron in the towns of Fowler, Hermon and Edwards, crystals of the forms represented in Figs. 144 and 162, are abundant. They are sometimes two inches in diameter, and are translucent or transparent. They also occur loosely in the soil, when they have a dark colour, are entirely opaque, and somewhat cellular, as if some portion of the material of the crystal has been dissolved out.

In the vicinity of Gouverneur, smoky crystals are found in the limestone, associated with tourmaline and other minerals. They sometimes exhibit the fused appearance already noticed. On the banks of Laidlaw lake, in the town of Rossie, there is a fine locality of crystallized quartz. The crystals are implanted, grouped, singly and sometimes doubly terminated; in the latter case, touching the rock only by the faces or angles of the prism. They are from half an

* Horton. *New-York Geological Reports*, 1839.

inch to three or four in length, and are transparent or translucent. The six-sided prism with six-sided pyramids is common; and there are also found the forms represented in Figs. 143 and 147, in Fig. 166, and the twins 167 and 168.

Fig. 166. Fig. 167. Fig. 168.



Near Grass lake, in the same town with the preceding, quartz is found in rounded and smooth masses, from the size of a pea to that of a pigeon's egg, having the lustre and other characters of hyalite. These masses seem to have been crystals which have been either wholly or partially fused. They are often penetrated by crystals of feldspar, and are found adhering to gneiss.* This is probably the variety to which Mr. Dana, in his Mineralogy, refers under the head of Hyalite.

Jaspery iron, or iron flint, is found at the Parish ore bed.

Saratoga County. According to Mr. Mather, quartz crystals are found in considerable abundance, in a rock intermediate between the calciferous sandstone and the limestone, in Galway in this county.

In the blue limestone near Saratoga-Springs, agate, passing into hornstone, is found. It is blue and white, and is sometimes beautifully striped, but the masses are not large.

Sullivan County. Crystallized quartz, usually in druses, and associated with galena, zinc, blende, copper and iron pyrites, is found at the well known lead mine two miles from the village of Wurtzboro'. This deposit is in a coarse sandstone, called *millstone grit*. The specimens are inferior to those found in the same range, and with the same associations, in Ulster county.

Ulster County. In the town of Wawarsing, near the Red bridge, and also near the village of Ellenville, crystallized quartz has been found in excavations which have been made for lead and copper ores. The associates are similar to those which occur in Sullivan county. At the Red bridge mine, a vast quantity of these crystals were obtained during the explorations which were carried on a few years since. These crystals were usually opaque and implanted, but were often translucent and doubly terminated. They have been found of from two to four inches in length.

At the Ellenville mine, the crystals are usually transparent, but they are much smaller than those from the preceding locality. Some interesting forms have been observed, which are represented on the next page, viz: Figs. 169, 170, 171, 172.

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* Emmons. *New-York Geological Reports*, 1837.

Fig. 169.

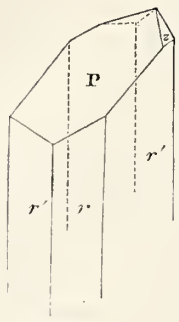


Fig. 170.

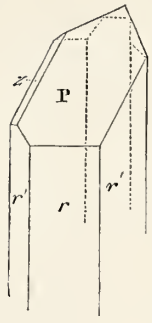


Fig. 171.

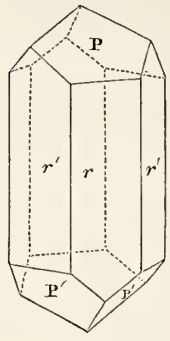


Fig. 172.

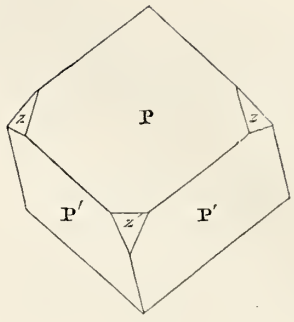
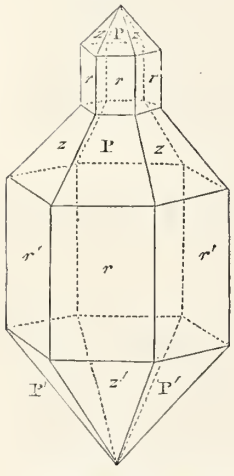


Fig. 173.



Figs. 135, 136, 149, also occur at this locality, with several other more common forms.

Crystallized quartz is also found abundantly at Flatbush in this county. Fig. 173 represents a compound crystal from that locality.

Warren County. On the islands in Lake George, and especially on Diamond island, four miles north of the village of Caldwell, very beautiful transparent crystals of quartz were formerly found in considerable abundance, in the calciferous sandstone. They were generally six-sided prisms, often with pyramidal terminations, and were sometimes four or five inches long, either loose or in cavities in the rock. One of these forms, described and figured by Dr. G. Troost, the *Quartz unibinaire* of Haüy (Fig. 174), is a hexahedral prism with the edges of their bases bevelled. P on *o* 128° 20′. In the same group were several of this form, and one having some of the solid angles of the prism truncated, forming a combination of the *rhombifère* of Haüy, and of the *unibinaire*, as in Fig. 175. These crystals were from a quarter to half an inch in length, and were found associated with calcareous spar.*

Fig. 174.

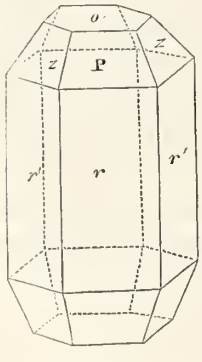
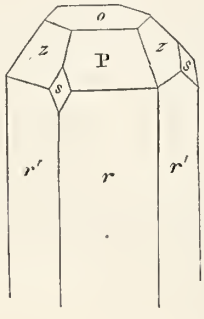


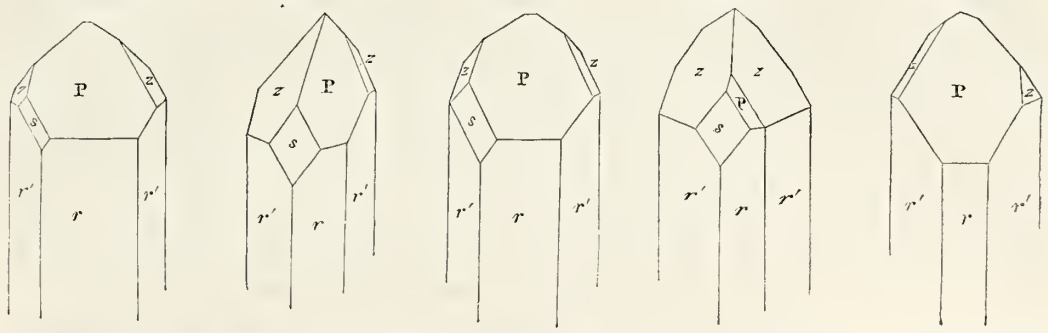
Fig. 175.



* Troost. *Journal of the Academy of Natural Sciences of Philadelphia.* II. 212.

Transparent and beautiful crystals, but which seldom exceed an inch in length, are still found in considerable abundance on Diamond island, and at Diamond point, about a mile north of the former. They are usually contained in cavities in the calciferous sandstone, and are associated with crystals of calcareous spar and pearl spar. Small particles of anthracite are also occasionally found in these cavities, as is the case in Herkimer county. Perfect crystals

Fig. 176. Fig. 177. Fig. 178. Fig. 179. Fig. 180.



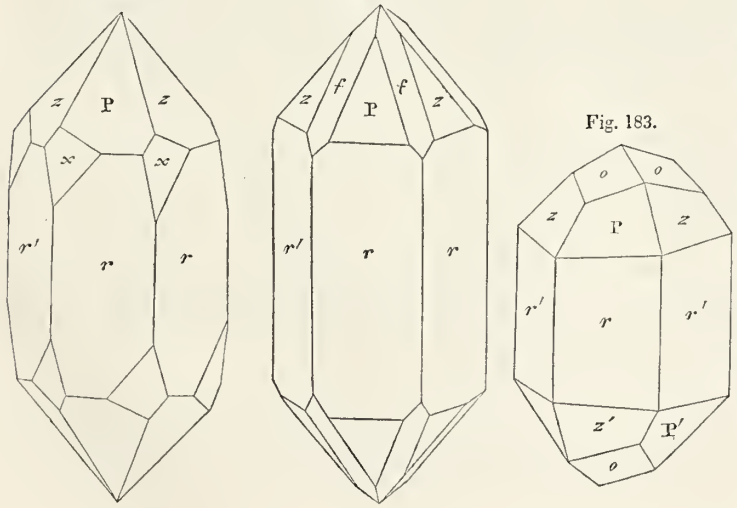
of large size are now very rare at these localities. Figs. 176, 177, 178 and 179 represent some forms obtained at Diamond Point. Fig. 180 is from Diamond island.

Westchester County. Drusy quartz occurs in geodes and cavities in hornstone, which almost approaches calcedony, in the vicinity of New-Rochelle. It is associated with serpentine and other magnesian minerals.

Common quartz is found in masses of some size, in the vicinity of the village of Yonkers, and also near West-Farms, where it is of a rose colour.

At the marble quarry at Hastings, there are veins of calcedony, from $\frac{1}{4}$ to $\frac{1}{2}$ inch in width, between the layers of the rock. The specimens are translucent, pale yellow and white.

Fig. 181. Fig. 182. Fig. 183.



To the above I add, Fig. 181, the *plagièdre* of Haüy, which, according to Shepard, is found on the White mountains in New-Hampshire; Fig. 182, the *émarginé* of Haüy, and Fig. 183 from Shepard, both of which occur at Quebec, Canada.

Fig. 181. P on x 148° 42′; r on x 167° 56′; z on x 125° 11′.

Fig. 182. P on f or z on f 141° 40′.

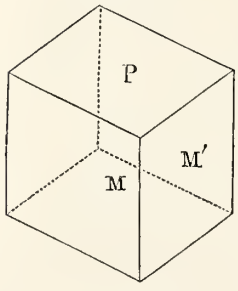
Fig. 183. P on o 160° 15′; o on o 125° 10′ (*Shepard*).

TABULAR SPAR.

Schaalstein. *Cleaveland.*— Spath en Tables, Wollastonite. *Haüy.* — Wollastonite, or Prismatic Augite. *Jameson.* — Prismatischer Augit-Spath. *Mohs.* — Bisilicate of Lime. *Thomson,* (who describes a new Wollastonite.) — Wollastonite. *Beudant.* — Tabular Spar. *Phillips, Shepard* and *Dana.*

Description. Colour white, with a shade of grey, yellow, red or brown. It occurs in granular and lamellar concretions; also massive and disseminated. The primary form is a right (or oblique) rhombic prism. Fig. 184. M on M′ 95° 20′. Principal cleavages parallel to the planes of the primary. Fracture splintery. Lustre pearly vitreous. Translucent to opaque. Brittle. Hardness from 4.5 to 5.0. Specific gravity from 2.80 to 2.90. Before the blowpipe, it melts with difficulty into a semi-transparent colourless enamel; with borax, it fuses easily into a transparent glass. It forms a jelly with muriatic acid, and the solution, after the separation of the silica, gives an abundant precipitate with carbonate of ammonia; and it may thus be distinguished from carbonate of lime, gypsum and tremolite, each of which tabular spar sometimes resembles.

Fig. 184.



Composition. The results of all the analyses that have been made of this mineral, concur in showing that it is a bisilicate of lime, but it is never free from small quantities of foreign matter. According to Stromeyer, it contains silica 51.45, lime 47.41, oxide of iron 0.40. Formula $Ca+2SiO_3$.

Geological Situation. It occurs in primitive limestone, in various parts of northern New-York.

LOCALITIES.

Essex County. At Willsborough, nine miles northwest of Essex, this mineral forms the sides of a powerful vein of garnet which traverses gneiss. It occurs in cleavable masses, white and translucent. A specimen from this locality was analyzed by Mr. Vanuxem.* Its composition was as follows:

Silica,	51.67
Lime,	47.00
Oxide of iron,	1.35

In the town of Lewis, about ten miles south of Keeseville, tabular spar is found in abundance, with similar associates as at the last named locality. The garnet exhibits various colours; it is massive, and in grains, forming the variety called *colophonite.* The tabular spar is very friable, and has a white or yellowish white colour.

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* *Journal of the Academy of Natural Sciences of Philadelphia.* II. 182.

About a mile and a half north of Lewis corners, there is another locality. The mineral here is snow-white, and closely resembles that from Easton in Pennsylvania. It is associated with garnet and quartz, the latter of which gives a sharpness to the masses of tabular spar, which it does not usually possess.

At Rogers' rock, near the line between this and the county of Warren, tabular spar occurs with characters similar to those observed in the specimens from Willsborough. It is associated with garnet, adularia and common feldspar.

The same mineral is not unfrequently found in loose masses in various parts of this county. It has thus been met with in the vicinity of Port Henry. As thus found, it has a greyish white colour, with a tinge of olive, and is highly translucent. It is associated with brown mica, and sparingly with scales of graphite.*

Lewis County. In the town of Diana, about a mile from the Natural bridge, is a large deposit of tabular spar in the limestone. It is of a snow-white colour, has a vitreous lustre, and closely resembles some varieties of tremolite. Its apparent purity induced me to subject it to analysis. Its composition is as follows :

Silica,	51.90
Lime,	47.55
Oxide of iron,	0.25

At this locality, the tabular spar is associated with green coccolite, and is exactly similar to the specimens which are found in loose masses in Oneida county. I have no doubt that this is the rock from which these bowlders have been detached.

There is another locality nearer to the Natural bridge than the preceding, where the mineral is abundantly found in detached masses. Here, however, it is of a greyish colour, and the folia are not so large or beautiful, nor is the lustre so high.

Oneida County. Large bowlders of tabular spar, associated with garnet, have been dug up in the village of Boonville. The specimens, as I have just stated, resemble those from Lewis county more nearly than those from Essex. The Essex county specimens are usually associated with garnet or colophonite, whereas those from Boonville and Diana have green granular pyroxene (coccolite) as their associate. I have compared specimens from the two localities, and find it very difficult to distinguish them. This is a fact of some interest in connection with the mode in which bowlders have been transported. Boonville is between forty and fifty miles directly south of the Natural bridge. These bowlders have been described by Prof. Hubbard, of Dartmouth College.†

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* Shepard. *American Journal of Science.* XVII. 140.

† *American Journal of Science.* XXXII. 230.

NEMALITE.

Nemalite. *Nuttall, Phillips, Shepard* and *Dana.* — Siliceous Hydrate of Magnesia. *Thomson.*

Description. Colour white, greyish and bluish white. It occurs in the form of elastic fibres, usually parallel, sometimes curved, and which are easily separable. It closely resembles asbestus. Lustre pearly. Translucent or opaque. Hardness about 2.0. Specific gravity from 2.35 to 2.44. By exposure to a red heat, it is rendered brown, gives out water, becomes brittle, and is easily reducible to powder. It, however, still retains its fibrous structure. Soluble in acids without effervescence.

This mineral closely resembles asbestus, and some varieties of Dr. Thomson's *stellite.* The action of the blowpipe, and of acids, will serve to distinguish it. Asbestus does not become brown or brittle before the blowpipe, like nemalite, nor is it soluble in acids. Stellite is fusible into a white enamel, and forms a jelly with muriatic acid.

Composition. Magnesia 51.72, silica 12.57, peroxide of iron 5.87, water 29.67 (*Thomson*).

Geological Situation. Nemalite has heretofore been found only in thin veins in serpentine and greenstone. It was first noticed at Hoboken in New-Jersey, by Mr. Nuttall.

LOCALITIES.

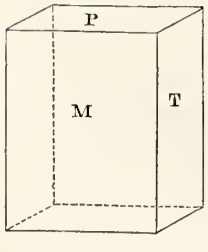
Rockland County. This mineral is found in very thin veins in the greenstone at Piermont, where it exactly resembles the specimens found at Hoboken and Bergen hill. It is not common at the former locality; and the stellite, which is more abundant, may easily be mistaken for it, as the fibres of that mineral are sometimes parallel.

SERPENTINE.

[From the resemblance which it sometimes bears to the skin of a serpent.]

Serpentine. *Cleaveland, Phillips, Beudant* and *Shepard.* — Precious Serpentine, or Hydrous Sesquisilicate of Magnesia. *Thomson.* — Prismatischer Serpentine-Steatit. *Mohs.*

Fig. 185.



Description. Colour various shades of green, particularly leek-green and mountain-green; also yellowish-grey and straw-yellow. It occurs regularly crystallized, also massive and disseminated. The primary form is said to be a right rectangular prism (*Shepard*). Fig. 185. The form of the crystals is generally so indistinct, that a few only of the faces can be traced. Texture compact, sometimes soft to the touch, tender but tenacious. Fracture conchoidal or splintery. Does not adhere to the tongue. Lustre resinous, inclining to pearly. Translucent, or translucent on the edges, to opaque. Hardness of precious serpentine, 3.5; of nephrite, 7.0.

Specific gravity from 2.50 to 3.00. Before the blowpipe, it becomes of a brownish red colour, hardens, but melts only with great difficulty on the edges; with borax, it fuses with difficulty into a green glass, which becomes almost white on cooling. By calcination, it loses water and becomes harder. It is partly attacked by acids.

Varieties. *Noble* or *Precious Serpentine.* This includes the translucent specimens, and has usually a green colour with a tint of yellow. It is harder than many other varieties, and its fragments often have very sharp edges.

Common Serpentine. It is of various shades of green, usually dark, and with brown or black intermixed. The colours are seldom uniform, but are arranged in stripes, veins, clouds, spots, etc. Its hardness is less than that of the precious serpentine, and its fracture is usually dull.

Nephrite. The colours are grey, green and white. It is massive, and in rolled pieces. Dull or glimmering. Fracture splintery. Strongly translucent, and difficultly frangible. Hardness 7.0.

Steatite or *Soapstone.* Colour white, red and yellow; often with markings of green, purple and black. Occurs massive, in crusts, and rarely in false crystals. Fracture splintery and uneven. It is soft, sectile, and has a very greasy feel. Somewhat translucent on the edges. Hardens before the blowpipe; becomes black, but is infusible.

Potstone. Has a greenish grey or leek-green colour; is coarse, and indistinctly granular. Its softness and tenacity are such that it can be readily turned on a lathe, and formed into vessels of various kinds. It is perhaps nothing more than a variety of indurated talc.

The *Picrolite* of Haussman, appears to be identical with serpentine. It is described as being massive or fibrous, with a radiated structure. Colour leek-green, passing into yellow. Translucent on the edges. Streak somewhat shining. Colours glass of borax green, but the colour disappears on cooling.

The *Retinalite* of Dr. Thomson, is probably also nothing more than a variety of serpentine.

The beautiful marble called *Verd antique*, is white limestone, with grains and spots of green serpentine. A notice of our principal localties of this valuable material will be found in the article on Marble (page 67). It is sometimes treated of in connection with serpentine, as it is to the presence of that mineral that the great beauty of this marble is to be ascribed.

Composition. *Precious Serpentine* — Silica 41.95, magnesia 40.64, alumina 0.37, protoxide of iron 2.22, water 11.68, carbonic acid and bitumen 3.42 (*Lychnell*).

Common Serpentine — Silica 42.16, magnesia 42.26, protoxide of iron 1.98, water 12.33, carbonic acid and bitumen 1.03 (*Lychnell*).

Soapstone, from Cornwall, Eng. — Silica 45.00, magnesia 24.75, alumina 9.25, potash 0.75, water 18.00, oxide of iron 1.00 (*Klaproth*).

Potstone, from Sweden — Silica 49.01, magnesia 30.20, alumina 6.08, protoxide of iron 11.40, water 4.20 (*Thomson*).

Picrolite, from Taberg in Sweden — Silica 40.98, magnesia 33.44, protoxide of iron 8.72, water 12.86, carbonic acid 1.73 (*Lychnell*).

It may be here observed, that the crystalline forms of serpentine have usually been considered pseudomorphs; and within a few years, M. Quernstedt has advanced the opinion that they are pseudo-crystals of chrysolite, the *peridot* of Haüy, and the *prismatic chrysolite* of Mohs. One variety of this mineral, the *olivine*, occurs in lavas and in trap rocks and greenstone; a fact which accords sufficiently well with the occurrence of these serpentine crystals, and of serpentine in the massive form, with or near the trappean or at least pyrogenous rocks. Moreover, the composition of the olivine would offer no objection to this view. According to Walmstadt, the olivine from Somma contains silica 40.08, magnesia 44.24, oxide of iron 15.26. But the strongest argument is the close similarity in the crystalline form. And the change in composition to convert olivine into serpentine, being chiefly that of the removal of oxide of iron and the substitution of magnesia, is not more remarkable than that which we know to have taken place in hornblende, scapolite, spinelle, and several other minerals. This view will moreover account for that want of perfection so marked in the crystals of serpentine.

Uses. When compact, and susceptible of a polish, it is highly esteemed for ornamental purposes. It may also be used for the preparation of some of the salts of magnesia. Soapstone, in consequence of its resisting the action of heat, is employed for lining furnaces, and other similar purposes. It has also been used as a cheap paint.

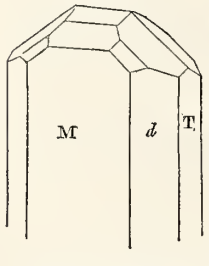
LOCALITIES.

Serpentine, in its different varieties, is quite abundant in this State. I shall notice only the more important localities.

Essex County. The precious variety, often having a very rich green colour, is found associated with white limestone in several parts of this county. In the immediate vicinity of Port Henry, there are fine specimens, both massive, and disseminated in small grains or angular fragments in the limestone, forming the verd-antique marble. Large blocks of this material may be here obtained. It is susceptible of polish, and exhibits all the characters for which the verd antique is so highly esteemed.

Jefferson County. In the town of Antwerp, two miles southwest of Oxbow, serpentine is found, which has a yellowish green colour, and is both massive and crystallized. It is in white limestone, and often has veins of amianthus running through it. Granular plumbago also occurs in the limestone. The crystals, although not entirely perfect, are much more so than is usual in this mineral. Fig. 186 represents one of the forms, but it is not easy to measure the inclination of the secondary faces.

Fig. 186.



The massive variety at this locality sometimes has a slaty structure, and it is then also harder and more brittle.

Lewis County. Extensive beds of a dark and compact serpentine occur in the immediate vicinity of Natural bridge. It sometimes passes into steatite, which is so soft as to be easily

cut and turned on a lathe. It is of various colours, from a very light green to nearly black, and is susceptible of a fine polish. Large blocks have been quarried at this locality, entirely free from checks and flaws which so often render this material valueless.

New-York County. On the Hudson river, near the city, there is a large bed of serpentine, with veins of amianthus;* while the same mineral, entirely resembling that at Hoboken, is frequently found in bowlders in the southern part of the island. Dr. Gale states that these bowlders are rare in the northern part of the island.

Onondaga County. On the hill a short distance east of the mansion of Major Burnet at Syracuse, there is a dyke or bed of serpentine, more or less mixed with limestone, and having various shades of colour, as bottle green, greyish green, and nearly black.

These serpentines were first noticed by Mr. Vanuxem, and described by him in his report of 1839, and he considers them new varieties for our country. "Some have a peculiar appearance, like bronze, owing to small gold-like particles with a lamellar structure, resembling bronzite or metalloidal diallage. There are also other particles highly translucent, like precious serpentine, with frequently small nuclei resembling devitrifications or porcellanites, coloured white, yellow, blood-red, variegated, etc. The grain of this kind is like common serpentine. In other kinds, the mass seems to be made up of small globuliform concretions, varying in size, being centres of aggregation. Some are of dark vitreous serpentine, others are of the compact kind, the enveloping part being of a lighter colour."†

These principal varieties produce endless mixtures upon the small scale, and numerous differences in the shades of colour.

According to Mr. Vanuxem, these serpentines seem to resemble the ophiolites of Tuscany; and should the views of Brocchi be correct, they may not only be similar in origin, but in age.

In regard to the chemical nature of these minerals, I have observed that all the specimens contain a large admixture of carbonate of lime. They almost all effervesce freely in acids; but there is always a nucleus of serpentine. The specimens are susceptible of a polish, and when sufficiently compact, and free from seams, exhibit in a striking manner the great variety of colours which the mineral possesses.

Orange County. There are several localities of serpentine in the towns of Cornwall, Monroe and Warwick. In the Forest of Dean in Cornwall, it is yellow and dark yellowish green, in imperfect crystals and grains, in white limestone.

The common variety of a dark colour is found associated with magnetic iron ore, at the O'Neil and Forshee mines in the town of Monroe. The quantity, however, is small.

There are several localities of the crystallized, massive and disseminated varieties in the town of Warwick. One of the most interesting of these is about two miles south of the village of Amity. It is found here in imperfect crystals, which are grass-green, yellowish green, and nearly black. The crystals are sometimes two and a half inches long and one and a half broad; and Dr. Fowler has noticed some, probably from the same locality, which

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* J. Van Rensselaer. *American Journal of Science.* XIV. 192.

† Vanuxem. *New-York Geological Reports,* 1839.

are from twelve to sixteen inches in circumference. He describes them as slightly rhomboidal prisms.* The crystals which I have seen are right rhomboidal prisms, with angles of about 105° and 75°. Sometimes, however, they approach the rhombohedral form, and at others again they are nearer to right rectangular prisms. The great diversity in crystalline form, and the bent and irregular appearance of the crystals themselves, lead me to believe that they have undergone changes since their original formation. Dr. Thomson suggests that they may be crystals of killinite, rather than of serpentine; but killinite melts by the blowpipe, which is not the case with our mineral. The associates of these crystals are crichtonite and spinelle. The same mineral also occurs massive at this locality.

In the vicinity of the village of Amity, there is a bed of verd antique, which is supposed to be of considerable extent; and on the east side of Long pond there is a large vein, the breadth of which is unknown. Its colour is dark oil-green, approaching to black.

Putnam County. In Phillipstown, five miles south of the village of Fishkill, serpentine of almost every variety occurs in a bed of white limestone. It is sometimes translucent, has the conchoidal fracture, and exhibits various shades from yellow through yellowish green to blackish green. Sometimes it is disseminated through the limestone in small grains, which occasionally have little circles of amianthus around them. There is also a slaty variety which has a dark green colour, breaks into irregular four-sided prisms, and is hard and compact. Another variety is of a greenish white colour, is harder than the preceding, and is fusible upon thin edges by the blowpipe. It quite closely resembles nephrite. But it is evident from an inspection of the locality, that however different the specimens may appear in the cabinet, they all belong to the same species. Indeed one variety passes into another by almost imperceptible gradations. All the differences which are here observable, are undoubtedly owing to foreign admixture. A portion of feldspar, or tremolite, or both, has replaced the serpentine, and thus produces those differences in character and appearance to which I have referred. This is another of those facts which should put mineralogists upon their guard in the announcement and description as new, of those minerals which differ from known ones princi pally in slight variations in chemical composition.

The verd antique, which is found at this locality, has not heretofore been obtained in blocks of sufficient size and solidity to answer the purpose of a marble.

There is a locality of serpentine in the same town with the preceding, about ten or eleven miles north-northeast of Peekskill, and about three quarters of a mile east of Horton's pond. The rock is of a blackish green, fine grained, and sometimes coarsely crystalline. It is yellowish on the weathered surface, and is associated with steatite. It seems to be sufficiently abundant to warrant its employment as a marble.†

Another locality, which is deserving of particular notice, is Brown's quarry, near Pine pond, and a mile and a quarter north-northwest from the county poor-house. It is dark coloured, from dark green to black, and varies in structure from compact to coarsely crystal-

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* *American Journal of Science.* IX. 242.

† Mather. *New-York Geological Reports,* 1839.

line. It is very abundant; may be obtained in large blocks, and when polished, has a perfectly black colour, and is highly esteemed for ornamental purposes..

In the fissures of this serpentine, there are veins of tremolite, schiller spar, and other allied minerals.

At "Cotton rock" in Phillipstown, three and a half miles below West-Point, precious serpentine occurs with veins of silky amianthus, whence the name of the locality.

Richmond County. Serpentine passing into steatite, and containing veins and masses of magnesite, asbestus, amianthus, talc, hydrate and carbonate of magnesia, is found at the quarantine. Indeed it constitutes the main ridge of hills on the island, which extends from New-Brighton to a little west of the village of Richmond, a distance of about eight miles. According to Mr. Mather, this ridge ranges N. 20° E. and S. 20° W., and the prolongation of the line of direction strikes the serpentine hills of Hoboken in New-Jersey. Throughout its whole extent, this rock exhibits the diversified characters which are observed at the Quarantine, or New-Brighton. This grouping of minerals, as in other cases, renders it quite difficult to distinguish the several varieties from each other. There are many intermediate or transition states of these serpentines, which, in hand specimens, might be considered as distinct; but an attentive examination of the locality will unfold their true character, and save the chemist much labor and anxiety.

Rockland County. Serpentine is found in grains and small masses in limestone, at several localities. Some of these have been noticed under the head of Marble (page 70). I am not aware that pure serpentine has been found in masses of any considerable magnitude.

St. Lawrence County. This mineral, in almost every variety, is very abundant in this county. In the form of *verd antique*, it is found in the towns of Gouverneur, Fowler, Edwards and Pitcairn (see page 70); while the variety soapstone is abundant in the towns of Edwards and Fowler. Indeed, in most of those places where the true serpentine is found, it passes into the softer varieties of steatite (soapstone), or into that mixture of pyroxene and steatite which Dr. Emmons has called *Rensselaerite*.

The crystallized variety, and the precious serpentine of a light green colour, occur in the immediate vicinity of the village of Gouverneur; and the same mineral in the massive form is found associated with calcareous spar, at Morris' natural dam, about two miles from that place. It is sometimes of a yellowish green colour.

In the vicinity of Gouverneur, crystals are also found, which have the form of scapolite in several of its modifications, but which appear to consist chiefly of serpentine or steatite. In accordance with the general views which have been drawn from the analysis of several supposed pseudomorphs of hornblende, pyroxene and spinelle, it is more than probable that these crystals are composed of a portion of the constituents of scapolite, another part of which has been replaced by serpentine or steatite. The only change necessary for this purpose, is the removal of a part of the alumina and lime, and the substitution of magnesia.

The serpentine at Gouverneur is frequently also replaced by the fibrous and radiated form of steatitic pyroxene, which is so frequently met with in this and in Jefferson county.

In the town of Rossie, two miles north of the village of Somerville, there is a locality of a very remarkable pale yellow and soft serpentine, which is found both massive and crystallized. The crystals are variously modified, but, as in other cases, they are seldom sufficiently perfect or well defined for accurate measurement. The general outline of some of these forms, however, may be easily determined.

Fig. 187.

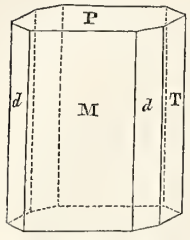


Fig. 188.

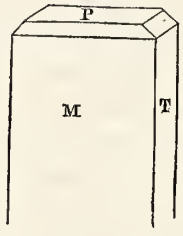
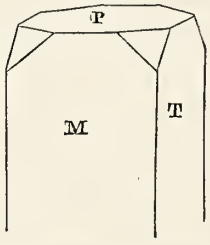


Fig. 189.



Figures 187, 188, 189, represent some of the modifications of the crystalline forms which have been observed in this county.

Warren County. Beautiful serpentine, of a yellowish green colour, occurs at Johnsburgh; and verd antique has also been found, equalling in beauty, whether the colours or polish be taken into the account, that which has been obtained in any part of the State. It is probable that when this county comes to be more thoroughly explored, it will be found to contain many interesting localities of the mineral in question.

Washington County. At the "Shelving rock" on Lake George, in the town of Fort-Ann, fourteen miles north of Caldwell, serpentine is found in white limestone. It is sometimes translucent and of a yellowish green colour, and passes by imperceptible gradations into a soft grey soapstone, of which there seems to be a considerable bed. The serpentine is often in small grains and spots in the limestone, and it may be sufficiently abundant to possess value as a marble.

Westchester County. Serpentine, in almost every variety, both of colour and structure, is found on Davenport's neck, about a mile and a half southeast of the village of New-Rochelle. It contains veins of magnesite, hornstone, calcedony, tremolite, and occasionally grains of chrome iron ore. This locality furnishes fine specimens for the cabinet; but although the mineral is abundant, it is so constantly traversed by veins of soft magnesite, asbestus, etc., as to render it almost impossible to obtain blocks of large size, which will answer as an ornamental marble.

Two miles north of the village of Rye, there are beds of serpentine, which is usually of an oil-green colour. It often has dark coloured grains of magnetic or chrome iron ore. Veins of magnesite also traverse the serpentine in various directions. These are sometimes several inches in width, and are made up of small rounded masses of this mineral, loosely cemented together by hydrate and carbonate of magnesia. Small specimens of this serpentine, as well as that at Davenport's neck, receive a good polish; but it is impossible to obtain large blocks free from cracks, and those veins of other minerals which render it useless as a marble.

The mineralogist, who is disposed to extend the number of species and varieties, will find, at both the localities just described, abundant opportunities for this purpose. Most of the species and varieties now included under the general names of *serpentine* and *magnesite*, may

here be obtained, but in some cases they will be found so closely associated with each other, that a specimen of ordinary size will frequently exhibit the gradual passage between the most widely different varieties.

MAGNESITE.

Magnesite. *Cleaveland, Beudant.* — Meerschaum. *Werner.* — Bihydrous Tersilicate of Magnesia. *Thomson.* — A variety of the Prismatic Talc Mica of *Jameson*, and of the Prismatischer Talc-Glimmer of *Mohs.* — Kerolite. *Shepard.* — Kerolite, and Hydrous Silicate of Magnesia. *Dana.* — Marmolite. *Nuttall* and *Beudant.*

Under the general name of *Magnesite*, I include several minerals which are essentially composed of silica and magnesia, and none of them containing any notable proportion of the carbonate of magnesia.

Description. Colour white, greyish, bluish, yellowish or reddish white. It always occurs massive, often tuberous and reniform. More or less earthy, always very tender. The powder is tolerably hard, and it has usually a smooth and unctuous feel. Fracture earthy and conchoidal. Hardness from 2.0 to 3.0. Specific gravity of magnesite from 2.60 to 3.40 (*Beudant*); of meerschaum, from 0.98 to 2.12. By calcination, it gives out water. It is with great difficulty fused by the blowpipe into a white enamel. It is partially acted on by acids.

Varieties. *Magnesite.* Greyish white, with a tint of red. It is soft, has a smooth and unctuous feel, but its powder is pretty hard.

Meerschaum. Colour snow-white. Fracture passing into flat, conchoidal. Surface smooth; fine grained. Sometimes it is very soft, and has the appearance of being a deposit from water.

Composition. *Magnesite*—Silica 54.00, magnesia 24.00, water 20.00, alumina 1.40 (*Berthier*).

Meerschaum—Silica 42.00, magnesia 30.50, water 23.00, lime 2.30, alumina with a trace of manganese 2.00 (*Thomson*).

Marmolite, from Hoboken, N. J.—Silica 40.00, magnesia 42.00, water 16.45, deutoxide of iron 0.90 (*Vanuxem*).

Kerolite—Silica 37.95, magnesia 18.01, water 31.00, alumina 12.18 (*Pfaff*).

Deweylite—Silica 40.00, magnesia 40.00, water 20.00 (*Shepard*).

Geological Situation. All the different varieties of this mineral are found in veins in serpentine, and sometimes in veins of trap. They are very closely allied to serpentine, with which this species ought perhaps to be united.

LOCALITIES.

Orange County. Near Greenwood furnace, magnesite of a greyish and yellowish white colour, occurs in veins of from a quarter to half an inch, in serpentine. It is associated with asbestus, but it is not abundant.

Richmond County. This mineral occurs in thin strata in the serpentine and magnesian marble near the Quarantine. It has a white streak and powder. Sectile. It adheres to the tongue. A specimen, according to my analysis, was found to contain

Silica,	41.00
Magnesia,	41.26
Water,	13.50
Lime,	2.39
Peroxide of iron, with a little alumina,	1.85

This is nearly identical in composition with the *marmolite* of Nuttall, found at Hoboken, N. J., and with the *magnesite* from the Bare hills near Baltimore. Both of these, indeed, according to Mr. Vanuxem, agree with precious serpentine from Newburyport, Mass.* There is, however, some difference between these minerals in regard to their structure.

Rockland County. Magnesite, or kerolite, of various shades of colour, as dull white, greenish and greyish white, and dark green, is found in narrow veins, seldom above an inch in width, in the trap dykes which pass up the northwestern face of Stony point. It is associated with other magnesian minerals, and is often traversed by thin veins of a beautiful silky amianthus. Some of the specimens can scarcely be distinguished from those of dewcylite, in colour and other characters. Its hardness is from 2.0 to 2.5. It yields readily to the knife. Powder white. Infusible by the blowpipe, except in very thin fragments, and then the edges are slightly rounded, and the mass becomes of a lighter colour.

The following is the composition of the Stony point mineral, viz:

Silica,	37.40
Magnesia,	32.56
Oxide of iron,	10.05
Water,	14.60
Alumina,	5.35
Oxide of manganese,	trace.

It differs from serpentine, and indeed from most of the varieties of magnesite, in the larger proportion of oxide of iron. In this respect, it is more nearly allied to picrolite than to any other mineral (see Serpentine, page 274).

Westchester County. This mineral is found in thin veins and in nodules in serpentine, in several parts of this county. At New-Rochelle, it is often white, and has an earthy efflorescent appearance exactly resembling some of the specimens found on Staten island. It is sometimes stained apparently by chrome iron ore. Occasionally the plates are highly polished on one or both sides, as if they had been subjected to the pressure of a very smooth surface while in a dissolved state.

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* *Journal of the Academy of Natural Sciences of Philadelphia.* III. 129.

Two miles north of Rye, is another and more abundant locality of the same mineral. It usually occurs in thin and very brittle plates of a white or light green colour. It has a somewhat resinous lustre, and is translucent on thin edges. Sometimes, however, it appears to be largely intermixed with true serpentine, and forms masses of considerable size. These masses are usually made up of angular fragments, separated from each other by thin seams of hydrate and carbonate of magnesia, the hydrate being in small pearly imperfect crystals or plates, and the carbonate in a white powder, probably resulting from the action of the atmosphere upon the hydrate.

According to my analysis of the green and compact portion, it contains

Silica,	40.50
Magnesia,	38.00
Water,	21.00
Oxide of iron,	traces.

This mineral, therefore, is quite similar in composition to that from Staten island.

The so called *Agalmatolite*, from Warwick in Orange county, is probably identical with this species; while the *Pseudolite*, (or the *pseudomorphs*, as they have been called, of hornblende, scapolite and spinelle,) which is supposed to belong to kerolite or magnesite, includes several mixtures of the minerals whose crystalline forms they represent, and some of the mineral matters which serpentine and magnesite are usually found to contain.

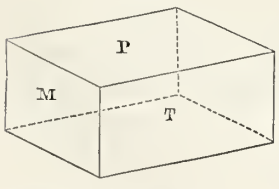
The general similarity in the chemical composition of the several minerals just noticed, sufficiently indicates their identity. The differences in some of the external characters may easily be accounted for, when we reflect upon the usual associates of these minerals, and the ease with which these associates are at least partly decomposed. Perhaps the most widely different variety is that of a dark green colour found at Stony point, and which uniformly contains from ten to twelve per cent. of oxide of iron. If I were to suggest a name for this mineral, it would be that of *Rocklandite*.

CHONDRODITE.

[From the Greek χονδρος, a *grain;* in allusion to its mode of occurrence.]

Chondrodite. *Berzelius* and *Thomson.* — Brucite. *Gibbs*, *Cleaveland* and *Shepard.* — Condrodite. *Haüy*, *Phillips* and *Beudant.* — Hemiprismatic Chrysolite. *Jameson.* — Hemiprismatischer Chrysolith. *Mohs.* — Maclurite. *Seybert.*

Fig. 190.



Description. Colour various shades of yellow, brown and red. It occurs massive and in small grains. According to Haüy, it cleaves parallel to the faces of a right oblique prism (Fig. 190), the greater angle of which is 112° 12′; but Cleaveland describes it as occurring in rhombic prisms of 124° and 56°, with dihedral terminations. Fracture imperfectly conchoidal. Lustre vitreous to resinous. Translucent. Hardness 6.5. Specific gravity from

3.11 to 3.25. Before the blowpipe, it is infusible, or fuses with great difficulty, but it loses its colour and becomes opaque. With borax, it fuses slowly but completely, into a transparent glass tinged by iron. The brown varieties act slightly on the magnetic needle. It is not acted on by acids. Acquires negative electricity by friction.

Composition. Magnesia 54.00, silica 32.67, fluoric acid 4.09, oxide of iron 2.33, potash 2.10, water 1.00 (*Seybert*). It is supposed to be a fluo-silicate of magnesia.

Geological Situation. It occurs in white limestone, associated with graphite, spinelle, hornblende and other minerals. It has seldom been found in any other rock.

localities.

Orange County. Chondrodite of almost every variety of colour, and sometimes imperfectly crystallized, is found in various parts of this county. It is usually associated with spinelle, and is imbedded in white limestone. In the town of Cornwall, three miles west of West-Point, and in the Forest of Dean, it is in small grains, which are usually of some shade of yellow. In the town of Monroe, at the so called *Silver mine*, it has nearly the same characters. Near Greenwood furnace, and at Two ponds, it is also found in light coloured grains in the usual gangue, and with the usual associate, spinelle. The same remarks will apply to its occurrence at Fall hill, in the same town.

In the town of Warwick, the localities are very numerous. Indeed it is more or less abundantly disseminated through all the beds of white limestone. Fine specimens may be obtained on the land of Mr. Houston, near Edenville. The principal colours are blood-red, orange and buff. The masses often have the appearance of highly modified crystals, but they are too imperfect to admit of measurement. The specimens from the vicinity of Amity are usually of a light yellow colour, are associated with spinelle, and, as in all the other cases, are in the white limestone.

After what has been said of the abundance of chondrodite in this county, it is unnecessary to extend the notice of particular localities. It is worthy of remark, that although there is so great a similarity between the minerals and rocks of Orange county and those of Northern New-York, chondrodite, so abundant in the former, is rarely found in the latter.

The occurrence of chondrodite in the limestone of Orange, has been referred by some to the segregation of the magnesia which it contains, and all the accompanying minerals have been considered as the direct result of the metamorphosis which the rock has undergone. Without wishing at present to reject this view, I would simply suggest whether, if it is correct, we might not fairly infer that chondrodite and spinelle should be found abundantly in the dolomite or magnesian limestone of New-York, Westchester, Putnam and Dutchess counties. But so far from this, chondrodite has not hitherto been found in even the smallest grains in this rock. There is, it is true, a doubtful locality near Carmel; but here, if in fact it does occur, it is associated with magnetic iron ore, hornblende and mica. I now believe the mineral to be a variety of serpentine.

St. Lawrence County. Chondrodite is found in white limestone on the bank of Laidlaw lake, in the town of Rossie, about two miles north of the village of Oxbow. It is in the form of small yellow grains, but it is not abundant.

Again, two miles from Somerville, in the same town, it occurs nearly of the same colour, associated with light blue spinelle. It is near the locality of buff serpentine and mica.

With the above exceptions, I know of no localities of this mineral in Northern New-York. It has, however, long been placed among the minerals of Rogers' rock, but I have never met with it at that locality.

In New-Jersey, chondrodite has been found abundantly in the county of Sussex, which adjoins that of Orange, N. Y.

BOLTONITE.

[From *Bolton* in Massachusetts, where it was first found.]

Boltonite. *Shepard* and *Dana.*

Description. This mineral, which, however, is still a doubtful one, has heretofore been found only massive. Its fracture is coarsely granular. Colour bluish grey, yellowish grey, wax-yellow to yellowish white. Streak white. Cleavage pretty distinct in one direction; in two others oblique to the first, indistinct, but affording indications of a doubly oblique prism for the primary form. Fracture uneven. Lustre vitreous. Transparent to translucent. Hardness from 5.0 to 6.0. Specific gravity from 2.80 to 2.90. Before the blowpipe, it becomes white and transparent, but is infusible; with borax, it yields a transparent glass.

This mineral was first found at Bolton, Mass., whence the above name was given to it by Mr. Nuttall. Dr. Thomson, several years since, described it under the name of *Silicate of magnesia;** but in his Outlines of Mineralogy, he remarks that it is intimately connected with picrosmine, with which it also sufficiently agrees in chemical composition. Many of the specimens so closely resemble chondrodite, that it is almost impossible to distinguish them by their external characters. They differ, however, in the proportions of silica and magnesia which they contain.

Composition. Silica 56.64, magnesia 36.52, alumina 6.07, protoxide of iron 2.46 (*Thomson*).

Geological Situation. Boltonite has heretofore been found only in white limestone.

LOCALITIES.

Orange County. Dr. Horton has introduced into his catalogue, three or four localities of boltonite; and the specimens from some of these have been recognized as identical with

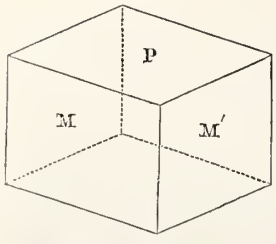
* *Annals of the Lyceum of Natural History of New-York.* III. 50.

those from Bolton, by Mr. Nuttall. One of these localities is four miles west of West-Point, in the town of Cornwall; another is four miles southeast of Woodbury furnace. In the town of Monroe, it occurs two and a half miles southeast of Monroe works; at the Two ponds; and in the Forest of Dean. At all these localities, it is found in the white limestone, and is associated with spinelle, hornblende, etc.

TALC.

Talc, and Chlorite. *Cleaveland.* — Chlorite. *Phillips.* — Prismatic Talc Mica. *Jameson.* — Prismatischer Talc-Glimmer. *Mohs.*

Fig. 191.



Description. Colour green, sometimes passing into greenish black; also greenish white, grey, and rarely blue. Streak corresponding to the colour. It occurs regularly crystallized; also massive, disseminated, and in amygdaloid pieces. The primary form is a right rhombic prism. Fig. 191. M on M′ 120°. Cleavage parallel with P. Fracture slaty, scaly, foliated, earthy and uneven. Lustre pearly on the terminal faces. Yields to the nail, and when in powder is unctuous to the touch. Thin laminæ are easily flexible, but not elastic. Ranges from translucent to opaque. Hardness from 1.0 to 1.5. Specific gravity from 2.70 to 2.80. Before the blowpipe, some varieties lose their colour, and are difficultly fusible; others are changed into a black scoria, and do not fuse at all.

Varieties. *Chlorite.* Under this name are included the dark green and generally opaque varieties; those which are regularly crystallized are called *Foliated Chlorite;* the slaty, *Chlorite Slate;* the massive, scaly and foliated, *Common Chlorite.*

Green Earth. This occurs in small masses, in, or lining the cavities of, amygdaloid. It is dull and earthy; yields to the nail, and is usually of dark green colour.

Talc. This name is usually given to those specimens which are white, or very pale green. Those which are most translucent, and have the highest degree of lustre, are called *Common Talc;* while those which are grey and green, with a slaty fracture and inferior lustre and translucency, receive the name of *Talc-slate* or *Indurated Talc.*

Composition. *Foliated Talc*—Silica 62.00, magnesia 27.00, oxide of iron 3.50, alumina 1.50, water 6.00 (*Vauquelin*).

Chlorite Slate—Silica 29.50, magnesia 21.40, oxide of iron 23.40, alumina 15.60, water 7.40, lime 1.50 (*Gruner*).

Green Earth—Silica 52.00, magnesia 6.00, oxide of iron 23.00, alumina 7.00, water 4.00, potash 7.50 (*Vauquelin*).

Geological Situation. Talc usually occurs in primitive mountains, sometimes forming whole beds. It is often associated with the different varieties of serpentine, to which indeed

it is closely allied. Sometimes it is found in primitive limestone, and in mica slate. The compact chlorite is found in amygdaloid and greenstone.

LOCALITIES.

Dutchess County. In the town of Fishkill, near Peckville, a little north of the line of Putnam county, there is a large bed of talc in the primitive rock, which has been opened as a quarry of soapstone. It is both grey and white, very soft and compact, or somewhat slaty. It contains a few fibres like asbestus, and sometimes has running through it long and slender crystals of hornblende. The imbedded minerals, and its unevenness of structure, render it unfit for the uses to which soapstone is applied.

New-York County. Common chlorite often occurs in the greenstone boulders in various parts of the island.

Orange County. There are several localities of common and foliated talc in the vicinity of the village of Amity. It is sometimes associated with clintonite.

In the town of Monroe, there is a variety which approaches very nearly to Venetian talc. It is heavy, compact, very soft and sectile ; writes on paper and cloth, and is translucent to opaque.

Putnam County. In Phillipstown, about eight or nine miles north-northeast of Peekskill, Mr. Mather informs us that the rock graduates, through every variety of aspect, from talc through steatite to serpentine.*

Rensselaer County. On the borders of Massachusetts, chlorite slate is found in strata of considerable extent, and which sometimes rise into hills of two or three hundred feet in height.

Richmond County. The finest specimens of talc heretofore obtained in this State, occur on Staten island. Both the common and the indurated or slaty varieties are found abundantly in veins traversing the soft serpentine near the Quarantine, and on the road to the village of Richmond. About four miles from the Quarantine, the talc is in detached masses made up of folia, of a snow-white colour, and resembles the specimens from Smithfield in Rhode-Island. The indurated variety, common near the Quarantine and elsewhere, is usually of a greenish colour, and has a distinctly slaty structure. Sometimes it has a flesh-red colour, and is both foliated and slaty. Besides these there are many other varieties, both as it regards colour and structure.

Westchester County. At Rye, chlorite is said to occur in considerable quantities, containing long slender crystals of schorl.†

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* Mather. *New-York Geological Reports*, 1839.

† Pierce and Torrey. *Cleaveland's Mineralogy.*

PYROXENE.

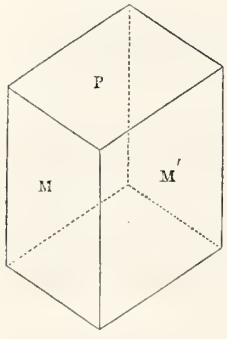
[From the Greek πυρ, *fire*, and ξενος, a *stranger;* because it was found in lava, to which Haüy considered it as not belonging.]

Augite. *Cleaveland* and *Phillips.* — Paratomous Augite. *Jameson.* — Paratomer Augit-Spath. *Mohs.* — Pyroxene. *Shepard* and *Dana.*

It includes Augite, Diopside, Mussite, Sahlite, Fassaite, Baikilite and Coccolite. Dr. Thomson makes a distinct species of White Augite, which includes Diopside, Mussite, Alalite, Sahlite and Malaeolite. The rest are united under his Pyroxene.

Beudant has a subgenus Pyroxene, under which he arranges as distinct species, Diopside, which includes the white and light green varieties; Hedenbergite, comprising those which are dark green and black; Pyrodmalite and Hypersthene. Between the two first it is, however, exceedingly difficult to draw the line of specific distinction.

Fig. 192.



Description. Colour green, black and brown; also grey and white. It occurs regularly crystallized; also in grains, and amorphous. The primary form is an oblique rhombic prism. Fig. 192. M on M′ 87° 5′; M or M′ on P 100° 10′ or 100° 25′. Cleavage parallel with M rather perfect, but interrupted; in some varieties, it is very perfect in the direction of P. Fracture conchoidal and uneven. Lustre varies from vitreous to resinous. Ranges from transparent to opaque. Hardness from 5.0 to 6.0. Specific gravity from 3.20 to 3.50. Before the blowpipe, it fuses, emits a few bubbles, and finally yields a glassy globule, more or less tinged by iron. It is readily soluble with borax. Several varieties of pyroxene have been obtained artificially by means of fusion.

Pyroxene often resembles hornblende, but can be distinguished by the difference in its crystalline form, and in its behaviour before the blowpipe.

Varieties. The following varieties of this mineral deserve to be particularly noticed:

Diopside — White Augite — Mussite — Alalite. This variety is generally crystallized. The colour is white or pale green. Translucent or transparent. The primary is an oblique rhombic prism, of the same form and measurement as that of pyroxene. Before the blowpipe, it fuses into a colourless semi-transparent mass; with borax, into a diaphanous glass.

Pyrgom — Pyrogome — Fassaite. This is generally of a dingy green colour; assumes nearly the same crystalline form, and yields to mechanical division parallel to the lateral planes of a prism of the same measurements as that of pyroxene.

Sahlite — Malacolite — Baikilite. It occurs in prismatic crystals of four or eight sides, with inclined summits. It is of a greenish grey colour. It often occurs massive. The structure is lamellar, and it has the same primary form as the preceding.

Common Augite — Conchoidal Augite. This includes all the varieties in which the colours are dark green and black, with a conchoidal and uneven fracture, and a resinous lustre. It is opaque or faintly translucent on the edges.

Coccolite — Granular Pyroxene. This presents various shades of green and bluish green, and occurs in small translucent masses or grains of irregular shapes, which cohere very slightly. They are, however, sufficiently hard to scratch glass. The structure is lamellar, and the lustre vitreous.

Jeffersonite. This was described as a distinct species by Keating. It occurs in lamellar masses of a dark olive-green colour, passing into brown. Lustre on the planes of cleavage, semi-metallic. It fuses readily before the blowpipe, into a black globule; not acted upon by the magnet.

Amianthus. This includes certain fibrous varieties; but it is rather a form belonging to several different minerals.

Composition. The different varieties differ somewhat in the proportions of their constituents.

White varieties—Silica 54.83, lime 24.76, magnesia 18.55, alumina 0.28, protoxide of iron 0.99 (*Bonsdorf*).

Green varieties—Silica 54.08, lime 23.47, magnesia 11.49, protoxide of iron 10.02, manganese 0.51 (*Rose*).

Black varieties—Silica 53.36, lime 22.19, magnesia 4.19, protoxide of iron 17.38, oxide of mangancse 0.09 (*Rose*).

Diopside—Silica 57.00, lime 16.50, magnesia 18.25, oxides of iron and manganese 6.00 (*Laugier*).

Coccolite—Silica 50.00, lime 24.00, magnesia 10.00, alumina 1.50, oxidc of iron 7.00, oxide of manganese 3.00 (*Vauquelin*).

Jeffersonite—Silica 56.00, lime 15.10, alumina 2.00, protoxide of manganese 13.50, peroxide of iron 10.00, oxide of zinc 1.00 (*Keating*).

The varieties of this mineral may be considered as composed of bisilicates of lime, magnesia, protoxide of iron or of manganese; but these are mixed in such variable proportions, that it is difficult to determine the exact formula.

Geological Situation. The white and light green varietics are usually found, in this State, associated with white limestone and dolomite; while the dark green ones occur in granite and gneiss, and often accompany the magnetic oxide of iron. The former are usually associated with, and often pass into, tremolitc. This is especially the case where they occur in dolomitic limestone.

localities.

Dutchess County. The white variety of pyroxene is found in the beds of dolomitic limestonc which traverse the eastern part of this county. It has not, however, been found in such abundance, nor so wcll characterized, as in the counties of Putnam, Westchester and New-York, which sec.

Essex County. Pyroxene, in almost all its varieties, is found in this county.

Fig. 193.

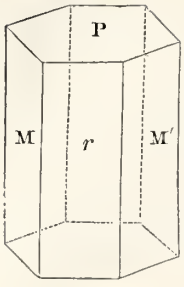
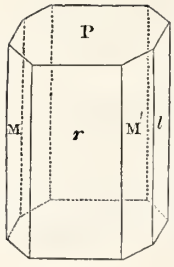


Fig. 194.



Commencing at the celebrated locality called *Rogers' Rock*, which rises from Lake George at or very near the line between this and the county of Warren, we find two or three varieties of this mineral in considerable abundance within the compass of a few acres. First, we have a crystallized variety of a greenish grey colour. It occurs in long prisms, which are six and eight-sided by truncations. Fig. 193, *périhexaèdre* of Haüy. Fig. 194, *périoctaèdre* of Haüy. M or M′ on *r* 133° 33′; P on *r* 106° 15′; M′ on *l* 136° 15′. One specimen was obtained here, which was between seven and eight inches in length, and of a proportionate diameter. These crystals, which, however, are seldom perfect, are associated with sphene, coccolite and feldspar. The sphene is sometimes imbedded in various parts of the prism of pyroxene.

Green, brown and black coccolite are also found at this locality. The grains are of various sizes, and sometimes cohere so slightly that it is difficult to retain specimens of any size. The green variety is less abundant than the others.

In a crystallized specimen from near Ticonderoga, probably from this locality, Mr. H. Seybert found,

Silica,	52.66
Lime,	23.33
Magnesia,	5.73
Alumina,	6.66
Protoxide of iron,	12.30
Water,	0.33
Oxide of manganese,	trace.*

A specimen of coccolite from the same locality, gave Mr. Seybert,

Silica,	51.00
Lime,	23.00
Magnesia,	6.26
Alumina,	3.00
Protoxide of iron,	14.43
Water,	0.66
Oxide of manganese,	trace.†

On Mount Defiance, near Ticonderoga, there is a fine locality of the variety sahlite. Its colours are greyish white and green. It cleaves easily and perfectly in the direction of P; and its faces of cleavage, which are large, have a high metallic, pearly lustre. It belongs to the variety sometimes called *Lamellar pyroxene*, and the specimens closely resemble those from

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* *Cleaveland's Mineralogy*, App. † Ibid.

Orange county, to be hereafter described. The composition, by my analysis, was found to be as follows, viz:

Silica,	51.35
Oxide of iron and alumina,	14.40
Lime,	24.25
Magnesia,	9.36

Near Kirby's graphite mine, four or five miles northwest of the village of Alexandria, crystallized and lamellar pyroxene are found in considerable quantities. Colour dull green. Cleavage seldom so perfect as in the specimens from Mount Defiance. It is associated with graphite, sphene and scapolite. The crystals are usually low six or eight-sided prisms, with the terminations highly modified; but I have not found any of them sufficiently perfect for measurement. They are generally imbedded in white scapolite.

Pyroxene of a nearly black colour (black augite), is found associated with magnetic oxide of iron at Crag harbour near Port Henry, on the immediate bank of Lake Champlain. It derives its colour from the iron ore with which it is associated. It is usually in large irregular grains, firmly cemented, and sometimes in imperfect crystals.

About half a mile north of Port Henry, the granular variety, of a light green colour, occurs in white limestone. It is sometimes intimately mixed with the carbonate of lime, by which its characters are somewhat changed. It is then less hard than pure pyroxene, and it effervesces strongly in acids. This mixed mineral still has the cleavage and lustre of pyroxene. In this we have an instance of those transformations which so frequently take place in the mineral kingdom, and of which many examples occur in the hornblende family.

At Willsborough, nine miles northwest of the village of Essex, granular pyroxene, (coccolite,) of a handsome green colour, occurs in a vein associated with granular garnet and tabular spar. It is nearly transparent, has a white powder and a semi-vitreous lustre. Specific gravity 3.377. Fusible before the blowpipe into a dark opaque globule. The composition is as follows:

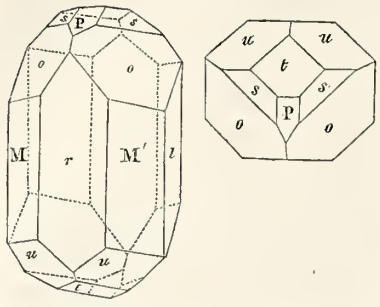
Silica,	50.33
Lime,	19.33
Magnesia,	6.83
Protoxide of iron,	20.40
Alumina,	1.53
Water,	0.66
Protoxide of manganese,	trace.*

According to Dr. Emmons,† crystallized pyroxene is found on Long pond. He has noticed, *Pyramidi*, with the faces *o* much extended in the direction of *s;* and the same with the faces

* H. Seybert. *American Journal of Science.* V. 116.

† *New-York Geological Reports,* 1837.

Fig 194.

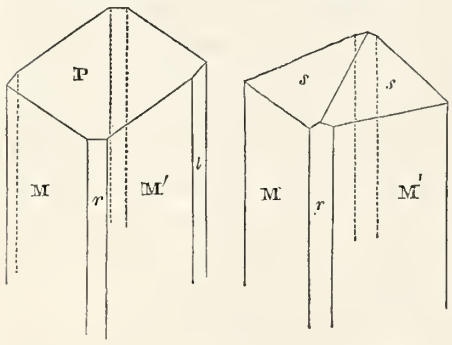


o contracted, *u* enlarged, the *stenonome* of Haüy, Fig. 194. Also, 1, With the faces *u* and *t* contracted, and *o* extended. 2, P enlarged. 3, *r* enlarged and extended in the direction M. M on *o* 145° 9′; P on *t* 147° 48′; P on *s* 150° 0′; M or M′ on *r* 133° 35′; *o* on *r* 118° 59′; *o* on *o* 95° 28′; *o* on *s* 156° 39′; *r* on *u* 126° 36′; *u* on *u* 131° 8′.

There is also, near the above locality, a very beautiful coccolite of a yellowish green and emerald green colour. Translucent to semi-transparent. It is associated with grains of a jet black colour, supposed to be black coccolite.

Herkimer County. Green coccolite is found about three and a half miles east of Salisbury Corners, in an aggregate of carbonate of lime, with which it is also intimately mixed.

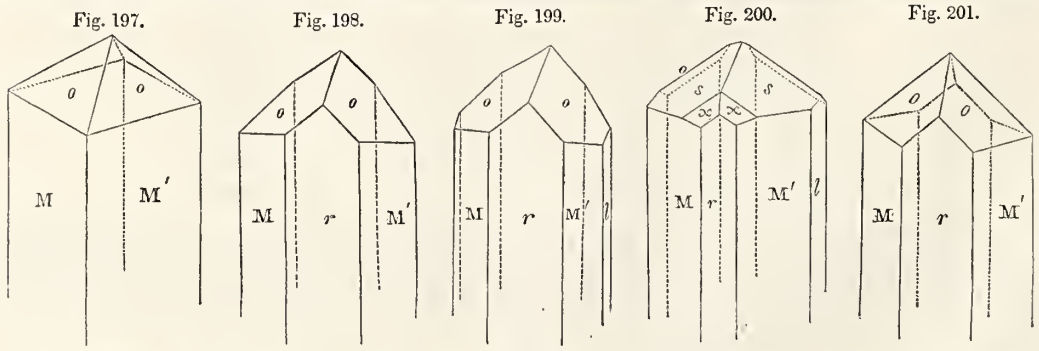
Fig. 195. Fig. 196.



Jefferson County. On the banks of Vrooman lake, near Oxbow, crystallized pyroxene, of a green colour, is found associated with crystallized mica. The forms are those represented in Figs. 195, 196; the former of which is the *périoctaèdre* of Haüy, with the faces *r* and *l* very narrow; and Fig. 196 is the *bisunitaire* of Haüy, with *r* contracted. M or M′ on *r* 133° 35′; M on *s* 121° 48′; *s* on *s* 120° 38′. It has not yet been found abundantly at this locality, but it will no doubt be so hereafter, both in this and other parts of this county.

Lewis County. In the town of Diana, crystallized pyroxene, of a jet black colour, is found associated with scapolite, feldspar and sphene, in white limestone. Among the forms here observed, may be mentioned the primary (Fig. 192); the primary with four terminal planes, Fig. 197, M on *o* 145° 9′, *o* on *o* 95° 28′; the *périhexaèdre* with two terminal planes, Fig. 198;

Fig. 197. Fig. 198. Fig. 199. Fig. 200. Fig. 201.



the *périoctaèdre* with two terminal planes, Fig. 199; the same with a differently modified termination, Fig. 200, M on *x* 134° 17′, *r* on *x* 126° 36′, *s* on *s* 120° 38′, *o* on *s* 156° 39′; a six-sided prism with four terminal planes Fig. 201; and also the same with eight sides.

A fine emerald green coccolite, associated with tabular spar, and quite similar to that of Willsborough in Essex county, is found in place, and in considerable abundance, about half a mile from the above locality.

New-York County. Crystallized pyroxene, of the white variety, is very often found in the dolomite of this island. It sometimes has a granular structure like the dolomite, and it not unfrequently is so much charged with carbonate of lime as to effervesce in acids. The crystals heretofore noticed are eight-sided prisms, with the two opposite sides often much larger than the other six, so as to present a tabulated form represented in Fig. 202. This, however, often has l enlarged to the dimensions of r. Another form is that represented in Fig. 203, in which the lateral primary planes are entirely obliterated by the new ones r and l; *périorthogone* of Haüy, l on r 90° 0′. The prism is variously terminated, sometimes as in Fig. 201, and at others they are more complex, giving rise to a new variety which Haüy (to whom the specimens were sent) named *épiméridé*.* Fig. 204. M on x 134° 17′; i on l 139° 7′; r on x 126° 36′; x on x 131° 8′. Specific gravity 3.10. The crystals are of various sizes, from minute to several inches in length, and they are imbedded in the limestone which crosses the island at its northern extremity, in greater or less abundance throughout its whole extent. The abandoned quarries at Kingsbridge, about 208th-street, also afford very good specimens.

Fig. 202.

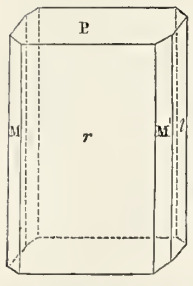


Fig. 203.

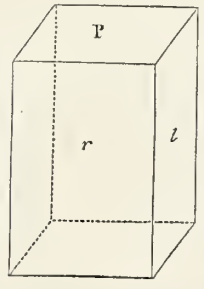
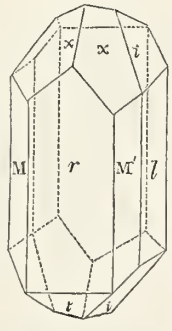


Fig. 204.



Oneida County. Large bowlders, made up of coccolite, glassy quartz and tabular spar, are found at Boonville. The coccolite is of a rich green colour, semi-transparent, and is equal in beauty to any in the United States. The specimens closely resemble those which are found in place in Lewis on the borders of Jefferson county, forty or fifty miles north (see Tabular spar, page 271).

Orange County. The mineral riches of this county are in no respect more remarkable than in the abundance and variety of pyroxenes which are found in it. If it were possible, it would perhaps be unnecessary, to enumerate all the localities, and I shall therefore confine myself to some of the more interesting ones. And it should here be stated, that we are chiefly indebted to Dr. Horton for what is known concerning these and other minerals of Orange county; and the reader who desires more particular information concerning them, is referred to that gentleman's Catalogue, published in the New-York Geological Reports of 1839.

The lighter coloured varieties of pyroxene, in this county, are usually found in white limestone; the darker ones are most generally associated with the magnetic iron ore. In many

* Troost. *Journal of the Academy of Natural Sciences of Philadelphia.* III. 105.

instances, the regular crystalline forms pass into the granular variety, which assumes various shades of colour from light green to nearly jet black.

In the town of Monroe, there are several interesting localities. One of the most noted of these is at the Two ponds, where it is associated with scapolite in large crystals, zircon and sphene, in white limestone. The colour is green to greyish green and brown. It is both massive and crystallized. The forms observed are the primary (usually small), six and eight-sided prisms with one terminal plane, Figs. 193 and 195; the *dihexaèdre* of Haüy, Fig. 205,

Fig. 205.

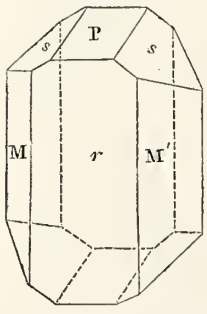


Fig. 206.

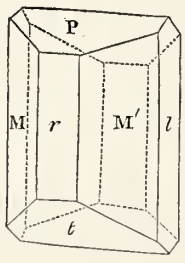


Fig. 207.

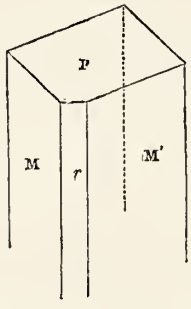


Fig. 208.

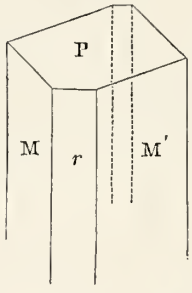
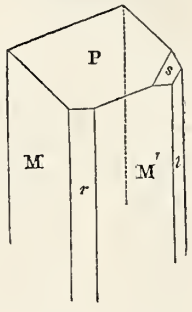


Fig. 209.



the size of the different planes being subject to great variation, M or M′ on *s* 121° 48′, P on *s* 150° 0′, *s* on *s* 120° 38′, *r* on *t* 106° 6′; the *quadrioctonal* of Haüy, Fig. 206; together with the forms represented in Figs. 207, 208 and 209. Sometimes these crystals are of large size, and are variously grouped.

About half a mile east of Greenwood furnace, in the same town, is another locality of pyroxene, which has afforded a great abundance of beautiful and interesting crystals.* The mineral is here associated with crystallized mica, which is equally worthy of attention. The colours of the pyroxene are green, greyish green, and ash grey. Among the forms are the primary and Fig. 195; together with those represented by Figs. 210, 211, 212 (*périoctaèdre* of Haüy), 213 (*bisunitaire* of Haüy), 214 (*octoduodécimal* of Haüy).

Fig. 210.

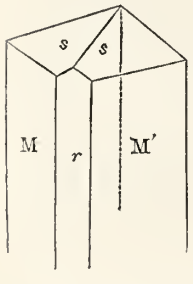


Fig. 211.

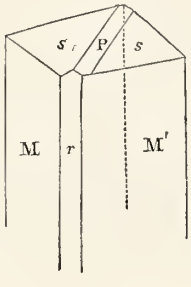


Fig. 212.

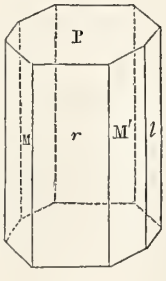


Fig. 213.

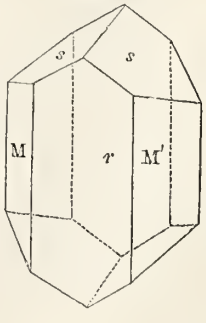
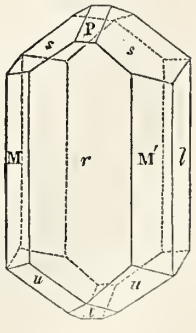


Fig. 214.



* For a notice of this locality, see *American Journal of Science*. VIII. 88.

One of the crystals found at this locality was nearly six inches in length, and ten inches in circumference; another was three inches long, and fourteen inches in circumference.* A fine green coccolite is found in the vicinity of this locality.

About two miles southeast of Greenwood furnace, this mineral, in the crystallized form, has also been found.

A mile northwest of the village of Edenville, pyroxene occurs in crystals of a dark green or nearly black colour. The form is usually the eight-sided prism with three terminal faces, but sometimes it is more complex. These crystals are associated with apatite, hornblende and sphene, in calcareous spar.

Fig. 215.

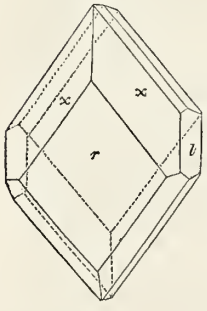
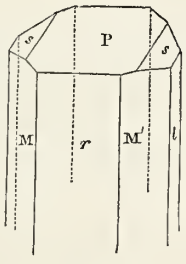


Fig. 216.



Two and a half miles north of Edenville, there occurs an interesting variety of crystallized pyroxene. The crystals are usually of a grey colour, rough on the surface as if they had undergone partial decomposition. Fig. 215 represents one of the forms, but the measurements can not be completed from any of the specimens which I have seen: l on x about 114° 26′; r on x 126° 36′; x on x 131° 8′.

In Warwick mountain, we have the forms represented by Figs. 193, 206, 208 and 216. P on s 150° 0′; s on s 120° 38′.

In the vicinity of the village of Amity in the town of Warwick, and of Fort Montgomery on the Hudson, there are localities of crystallized pyroxene; but no forms, other than those already noticed, have been observed.

The lamellar variety is found, of great beauty, in the Forest of Dean, in the town of Monroe. It is of a dark green and bronze colour, with a fine lustre and distinct lamellar structure, yielding readily to cleavage in the direction of the primary prism. It is associated with sphene and scapolite. Laminæ may here be obtained of from four to six inches in diameter, but they are sometimes so small and irregular that the mineral appears granular.

Another beautiful variety of sahlite is found about three miles southeast of Greenwood furnace. It exhibits a very distinct lamellar structure, and has a bronze or copper colour, and often a metallic lustre. It closely resembles some of the specimens of so called *hypersthene* from the northern part of the State.

On the immediate bank of the Hudson, three miles above West-Point, the lamellar variety occurs associated with quartz, black and bronze-coloured mica and feldspar. A specimen from this locality was analyzed by Mr. Vanuxem. The specific gravity is about 3.24. Its composition is

* *American Journal of Science.* VIII. 88.

Silica,	51.00
Lime,	21.00
Magnesia,	11.50
Alumina,	3.50
Peroxide of iron, with a trace of manganese,	11.53
Water,	1.00*

Lamellar pyroxene of a dark colour, and exhibiting cleavage in the direction of P, is found at many of the localities of magnetic iron ore in the town of Monroe, as at the Forest of Dean mine, the Rich iron mine, Long mine, Mountain mine, Patterson mine, Sterling mine, Cross-way mine and O'Neil mine. There is a great deal of similarity in the characters which the mineral presents at these different localities.

The granular variety coccolite is also exceedingly abundant in this county. In the town of Monroe, a mile west of Coffee's hotel, it is in small grains, perfectly black. Near Green-wood furnace, it is light green and translucent, and often in large grains which admit of cleavage. Again, in the Forest of Dean, it is black; and the same character will apply to that which occurs at the Forshee and O'Neil mines, as well as that from Bull's pond in the same town. It is also found at Rocky hill in Warwick, and in the town of Cornwall, four miles west of West-Point.

At some of the above localities, pyroxene is found in such abundance as to constitute rocky masses; and there is often observed at, or near, the same spot, the crystallized, the lamellar and the granular varieties, passing into each other, and varying in colour, so that it becomes almost impossible to indicate the line of distinction between them.

Putnam County. At Hustis' farm in Phillipstown, there is a variety of pyroxene which has been called *diopside*. It is translucent, has a light green colour, lamellar structure, and a glistening surface. It sometimes contains small crystals of pale green apatite. Associated with it are white, rose-coloured and green coccolite. The whole is contained with serpentine and other allied minerals in white limestone. The white coccolite was formerly considered a new variety. It is made up of grains of various sizes, and resembles dolomite. Pyroxene, crystallized in eight-sided prisms, has been found at Coldspring in this county, where other varieties, similar to those just noticed, also occur.

About two miles south of the village of Carmel in the town of Southeast, there is a dark green, almost black, coccolite, associated with crystallized epidote, hornblende, etc. It is not, however, abundant. Pyroxene also occurs on Townsend's farm, about half a mile north of the preceding locality.

In the dolomitic beds near Patterson, crystallized white pyroxene is very abundant; so much so, that in some places it greatly injures the value of the limestone for the uses to which it is ordinarily applied. In some places, the surface of the little elevations of the rock is

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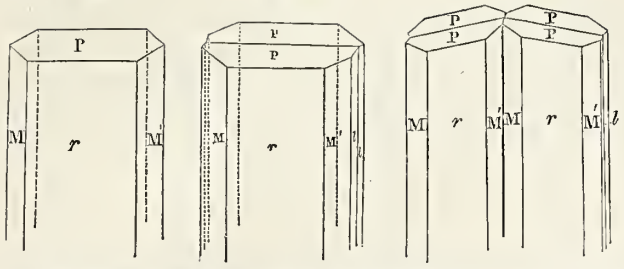
* *Journal of the Academy of Natural Sciences of Philadelphia.* III. 68.

Fig. 217. Fig. 218. Fig. 219.



strewed over with loose fragments of crystals. They are usually of the form represented in Fig. 217, which is the *périhexaèdre* of Haüy, with the face *r* much extended, and the other faces very narrow, so as to give the crystal the appearance of a flattened table.

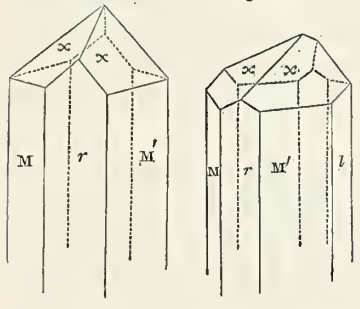
Near Knapp's quarry, twin crystals of white pyroxene have been obtained, the composition of which will be understood from an inspection of Figs. 218 and 219. They closely resemble the compound crystals of albite.

Rockland County. At the Horsenclever iron mine, in the town of Haverstraw, fine specimens of the lamellar variety are found, which closely resemble hypersthene.

St. Lawrence County. About a mile southwest of the village of Gouverneur, there is a locality of crystallized pyroxene of a light grey colour. The forms are the primary, and an eight-sided prism, but they are usually without terminations. They are associated with crystallized hornblende and dark green coccolite, and occur in white limestone.

In the town of Rossie, two miles north of the village of Oxbow, crystallized pyroxene occurs in an aggregate of feldspar, apatite, crystallized hornblende and sphene. It is of a green and greyish green colour. Large crystals have been obtained at this locality. They are usually of the primary form (Fig. 192), and the modifications Figs. 207 and 208.

Fig. 220. Fig. 221.



Near De Long's mill, in the town of Hammond, crystallized pyroxene of a dark colour occurs along with zircon, feldspar and apatite. The forms are six and eight-sided prisms with four terminal planes, represented in Figs. 220 and 221. M on *x* 134° 17′; *l* on *x* 114° 26′; *x* on *x* 131° 8′.

Lamellar pyroxene, of a white and greyish white colour, is found in abundance near the village of Richville in the town of De Kalb. It cleaves like most of the varieties, but it is often softer than is usual with this mineral. I attribute this to its mixture with serpentine, and it probably belongs to that variety which I call *steatitic pyroxene*, to be presently noticed. It is associated with tremolite and brown tourmaline, the whole contained in white limestone.

Washington County. In the town of Putnam, on the bank of Lake George, about two miles south of Ticonderoga, there are beautiful specimens of lamellar pyroxene. The colour varies from grey to nearly black, and some specimens have a high pearly lustre on the faces of cleavage, while others have a metallic lustre. It is both foliated and lamellar; and the folia, which are sometimes waved or bent, may be obtained of the size of the hand. The latter variety is apparently less hard than is usual with this mineral, but this is probably owing to its structure.

As this mineral closely resembles what has been termed hypersthene, I submitted it to a chemical examination, chiefly for the purpose of determining the proportion of lime which it contains; this, so far as composition is concerned, being the chief difference between pyroxene and hypersthene. The composition of the Lake George mineral is as follows:

Silica, alumina and oxide of iron,	56.94
Lime,	24.06
Magnesia,	29.00

The large proportion of lime places this mineral under pyroxene. The proportions of the other constituents also agree with those found in some varieties of this species.

Westchester County. Pyroxene, in various forms, is often met with in the dolomitic beds of this county. The crystallized white variety, usually in six-sided tables, is found in the quarries at Sing-Sing and elsewhere. The common variety has been found at Sparta. The dolomite, moreover, often contains a substance with the cleavage of pyroxene, but which is soft, and has a considerable admixture of carbonate of lime and magnesia. The external characters strongly resemble those of white lamellar pyroxene; but the effervescence which is exhibited when the mineral is acted on by a dilute acid, shows that it is largely mixed with one or both the carbonates above mentioned.

Dr. MacCulloch long ago remarked that in Tirey (Scotland), crystals of tremolite and sahlite are so confounded, that a single crystal sometimes contains both substances, as if there was a transition between the two minerals.* I have observed the same thing in the dolomitic limestones of Westchester and Putnam counties; tremolite and pyroxene occurring in immediate contact with, and indeed running into, each other. Veins of glassy tremolite every where run through a dull white mineral, which has the cleavage of pyroxene.

Pyroxene is also found near New-Rochelle; but it is so closely associated with hornblende and serpentine, that it is not easy to identify it.

Fig. 222.

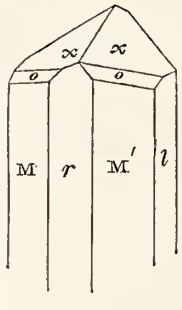
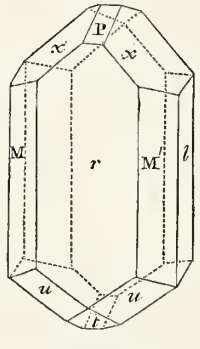


Fig. 223.



I will only add, that Fig. 222 represents a crystal obtained by Dr. Emmons from Warren county. M or M′ on *o* 145° 9′. Fig. 223 is the form of crystallized pyroxene from Bytown in Canada. The latter figure is introduced on the authority of Prof. Shepard. M or M′ on *x* 134° 17′; *x* on *x* 131° 8′; *r* on *t* 106° 6′; *u* on *u* 131° 8′; *x* on *r* 126° 36′.

In Massachusetts, crystals of diopside are found in limestone at Bolton, where the massive sahlite also occurs. In Connecticut, also, there are several localities of this mineral, as at Canaan and New-Milford.

The variety Jeffersonite is found at the Franklin furnace, and elsewhere, in New-Jersey.

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* *Brewster's Edinburgh Journal of Science*, I. 225.

APPENDIX.

Steatitic-Pyroxene — Rensselaerite of Dr. Emmons. Before leaving Pyroxene, I must introduce a notice of what I consider to be a variety of it, described by Dr. Emmons as a distinct species.*

Description. Colour white, yellowish or greyish white, and dark. Occurs in soft cleavable masses, the primary form of which is an oblique rhombic prism. M on M′ 94° 00′; P on M 106° 30′, according to Emmons. By my measurement of the white variety, its angles do not differ from those of pyroxene (Fig. 192). Fracture uneven. Opaque. Hardness from 3.0 to 4.0. Specific gravity 2.874. Before the blowpipe, it fuses with difficulty into a white enamel.

Composition. According to my analysis, the composition of a specimen from Canton in the county of St. Lawrence, is as follows, viz:

Silica,	59.75
Magnesia,	32.90
Lime,	1.00
Peroxide of iron,	3.40
Water,	2.85

The above results agree very well with those obtained from some varieties of what Beudant calls *Steatitic Pyroxenes* from Sahla, and which contain variable proportions of foreign matter.

This author quotes three analyses of Rose, the composition of one of which is as follows:

Silica,	60.65
Lime,	4.97
Magnesia,	25.20
Protoxide of iron,	4.18
Oxide of manganese,	0.78
Water,	4.38

This substance has the form and cleavage of pyroxene. According to calculation, it contains pyroxene 37.40, steatite 62.30, hygrometric water 0.40.†

I have little doubt that the mineral in question is a mixture of a similar kind. The steatite to which it owes its somewhat soapy feel, and its softness, has been intruded into it without disturbing the crystalline form of the pyroxene. What has caused this partial decomposition of the pyroxene, and the intrusion of the foreign matter, is not so easy to determine. Cases of a similar kind are, however, by no means rare, especially in the species hornblende, and even in spinelle, as will be hereafter noticed.

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* *New-York Geological Reports*, 1837.

† Beudant. *Traité Elémentaire de Minéralogie*. I. 224.

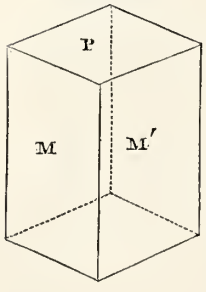
HORNBLENDE.

Amphibole. *Haüy* and *Thomson.* — Hornblende. *Phillips, Shepard* and *Dana.* Hemiprismatic Augite. *Jameson.* — Hemiprismatischer Augit-Spath. *Mohs.*

Cleaveland includes under Hornblende only the dark-coloured varieties. He has Tremolite as a distinct species, and Actynolite as a subspecies under Hornblende. Beudant has a subgenus Amphibole, and under it he places Tremolite and Actinote as species. Phillips includes under the general name Hornblende, Common Hornblende, Pargasite, Tremolite, Pyrallolite, Actynolite, and Asbestus. As it is exceedingly difficult to draw the line between these varieties, I shall follow this author.

Description. Colour green, white, black, grey, blue and brown. It occurs regularly crystallized; also in lamellar and fibrous masses. Primary form an oblique rhombic prism. Fig. 223 (*bis*). M on M′ 124° 30′; M or M′ on P 103° 1′. Cleavage parallel with M highly perfect; less distinct parallel with P, and with the diagonals of the prism. Fracture conchoidal, uneven and slaty. Lustre vitreous, vitreo-pearly, pearly and vitreo-resinous. Ranges from transparent to opaque. Hardness from 5 to 6. Specific gravity from 2.90 to 3.35. Fusible before the blowpipe, with more or less ease, into a white translucent or opaque glass, or into one that is green or black, depending upon the variety. It is not easily attacked by acids.

Fig. 223 (*bis*).



Hornblende is distinguished from diallage and hypersthene chiefly by its cleavage. Diallage has only one distinct cleavage; hypersthene three, of which two are silvery, and one copper-like; while hornblende has only two, and moreover by transmitted light displays a deep red colour. It is more difficult to distinguish hornblende from pyroxene. Prof. G. Rose has indeed proposed to unite them, and he has presented a great number of facts in favour of their identity.*

Varieties. *Hornblende — Carinthin.* This includes all those varieties with dark green and black colours, whether crystallized or massive. The lustre varies from pearly to pearly-vitreous. It is usually opaque, and before the blowpipe, fuses into a black brilliant glass. The term *basaltic* has been particularly applied to those cleavable and highly crystalline black hornblendes which occur in basaltic and amygdaloidal rocks.

Pargasite. A name originally given to a hornblende from Pargas in Finland. It is somewhat translucent, and is usually of a bottle-green colour. In other respects, it agrees with the preceding variety.

Actynolite and *Calamite.* These are light green, greenish grey, and sometimes brown and yellow. They are seldom crystallized, (and then generally in reed-like crystals;) more fre-

* *Allan's Manual of Mineralogy*, 149.

quently they are massive, and in radiated fibrous and granular concretions. The lustre is vitreous or pearly, and they vary from transparent to opaque.

Tremolite — Grammatite. The colour of this variety is white, occasionally with a tinge of grey, green or blue, but lighter than actynolite. It occurs in masses composed of delicate crystalline fibres, which sometimes radiate. Lustre shining or glistening, and pearly or vitreo-pearly. Ranges from translucent to translucent on the edges. Before the blowpipe, it fuses into an opaque white enamel.

Asbestus. Under this term there are no doubt now arranged several distinct minerals, the form of flexible silky fibrous concretions being in many cases the result of atmospheric agencies. The colour of the hornblende asbestus is various. When the fibres are long and slender, are easily separated and more or less elastic, they form the *Amianthus.* Other varieties, which are of a white or grey colour, and have the fibres interlaced so intimately as not to be capable of separation, and so light as to float in masses on water, are called *Mountain Cork.* When the colours are green, and the fibres are disposed in straight, shining, pearly, rigid, fibrous concretions, the name *Rigid* or *Common Asbestus* is applied. And those varieties in which the colour is wood-brown, and in general aspect much resembling fossil wood, are named *Rock-wood,* or *Ligneous Asbestus.**

Composition. The different varieties differ somewhat in their chemical composition.

Black Hornblende—Silica 45.69, magnesia 18.79, lime 13.85, alumina 1.18, protoxide of iron 7.32, fluoric acid 1.50 (*Bonsdorf*).

Green Hornblende—Silica 46.26, magnesia 19.03, lime 13.96, alumina 14.48, protoxide of iron 3.43, protoxide of manganese 0.36, fluoric acid 1.60, water, etc. 1.04 (*Bonsdorf*).

White Hornblende—Silica 60.31, magnesia 24.23, lime 13.66, alumina 0.26, protoxide of iron 0.15, fluoric acid 0.94, water and foreign matter 0.10 (*Bonsdorf*).

Amianthus — A variety with a greenish-white colour—Silica 55.91, magnesia 27.07, lime 14.63, alumina 1.82, protoxide of iron 6.52 (*Thomson*).

Geological Situation. Hornblende abounds in the primary regions of the State, and is rarely found elsewhere, unless associated with trappean rocks. Hence the most important localities occur in the southern and northern counties. It is especially abundant where beds of white limestone or dolomite occur in the primary ranges, and the presence of hornblende is usually an indication of the existence of other minerals in the vicinity.

As there are very numerous localities of this mineral in this State, I shall only introduce those which afford well characterized specimens of one or other of the varieties.

LOCALITIES.

Dutchess County. Near a hamlet called Peckville, in the town of Fishkill, there is a

* Mr. Allan correctly remarks, that greatly as black crystallized hornblende and white silky asbestus differ in aspect, specimens exist in which the passage of the one into the other is distinctly visible. *Manual of Mineralogy.*

beautiful actynolite of a pale green colour, in a white talcose rock. It is in long slender prisms both straight and bent, and intersected by transverse seams.

Tremolite of a white and bluish white colour, is found in the white limestone in various parts of the town of Dover. It is similar to that to be hereafter described as occurring in New-York and Westchester counties.

Essex County. There are localities of common hornblende in various parts of this county. At almost all the mines of magnetic iron ore, it is one of the accompanying minerals. It is usually black and massive; sometimes it is white, has a high vitreous lustre, and is streaked in the direction of the cleavage surfaces. Such specimens often occur at the Crag-Harbour mine, near Port Henry.

Fig. 224.

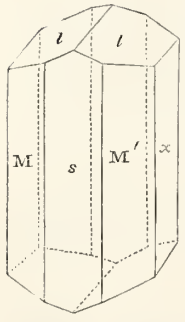
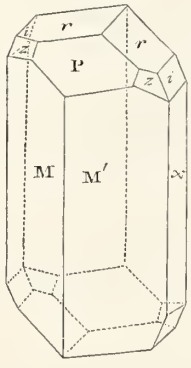


Fig. 225.



At Willsborough, nine miles northwest of the village of Essex, small but perfect black crystals are imbedded in black tourmaline. The forms are the *triunitaire* of Haüy, Fig. 224; and the *accélére* of Haüy, Fig. 225. M on *s* 152° 17′; M′ on *x* 117° 43′; *l* on *x* 105° 11′; *l* on *l* 110° 2′; *r* on *r* 149° 38′; *i* on *x* 129° 8′ (*Shepard*).

Fine massive black hornblende, having a high lustre, is found at the Barnum iron mine, about six miles west of Port Henry. It forms a part of the walls of the mine. The same variety also occurs near the locality of garnet and tabular spar in the town of Lewis.

At the Sanford ore bed, in the western part of Moriah, there is a variety of actynolite quite similar to that found in Orange county. And at another mine having the same name, six miles west of Port Henry, veins of asbestus run through the ore and the accompanying rock.

Of the granular variety of hornblende, it is scarcely necessary to enumerate the localities, as it is found at almost all the deposits of iron ore.

Jefferson County. In the vicinity of Watertown, there are two varieties of tremolite. The one is in the form of white translucent fibres, or bundles of fibres, which are variously bent or divergent; the other is dark brown, greyish brown and greyish white, and consists of bundles of flat prismatic fibres which are bent and divergent.

The variety amianthus occurs in thin veins, associated with serpentine, in the white limestone near the village of Oxbow.

New-York County. A beautiful white and bluish white tremolite is found in the quarries of dolomite at Kingsbridge. In some cases it is in broad laminated masses, which have a semi-crystalline structure and a high vitreous lustre, and is intersected by transverse seams. Other specimens exhibit fasciculated groups of minute, diverging or interlacing fibres. It is not unusual, in this and the adjoining county, to find the tremolite passing into pyroxene; and the purest specimens usually effervesce slightly with acids, in consequence of the mixture of dolomite. The folia of tremolite, occurring at Kingsbridge, are sometimes six to nine inches in length.

The variety, actynolite, is found in bowlders at Corlaer's Hook, and in other places in the southern part of the island.* The variety amianthus is frequently found in thin veins in serpentine. The mineral formerly called *Radiated asbestus,* is the *Hydrous anthophyllite* of Thomson.

Orange County. This county is rich in hornblende, in almost all its varieties. The localities are principally in the towns of Cornwall, Monroe and Warwick.

In the town of Cornwall, there is a locality four miles west of West-Point, and another four miles southeast of Woodbury furnace.

In the vicinity of Florida, there is a crystallized green hornblende, which in its structure resembles tremolite.

In the town of Monroe, near the Two ponds, hornblende, occurs in the white limestone. It is black and green. The crystals are sometimes six-sided and perfect, but they are most generally rounded, and have a fused appearance similar to that exhibited by many of the minerals in St. Lawrence county, and which is thought to favour the theory of the igneous origin of white limestone. At the same locality, and elsewhere in this town, long four-sided prisms of dark hornblende are found in trap. Near the Greenwood furnace, hornblende occurs in six-sided prisms with dihedral summits; and there is also, in the same vicinity, a black shining granular hornblende.

Fig. 226.

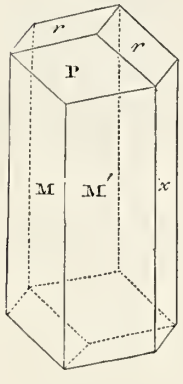


Fig. 227.

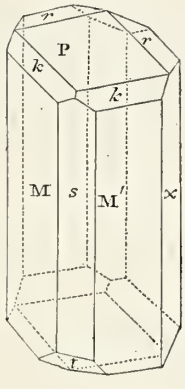
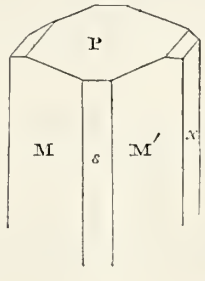


Fig. 228.



At the Stirling mine, crystallized hornblende, of a dark green colour, is found associated with ilmenite in feldspar. There have been obtained at this locality, the *dodécaèdre*, Fig. 226; and the *octoduodécimal* of Haüy, Fig. 227; and modifications of the latter form. The crystal represented in Fig. 228, has also been found in this town. M or M′ on *s* 152° 17′; M′ on *x* 117° 43′; *k* on *k* 55° 4′; *k* on *x* 102° 22′; *r* on *r* 149° 38′; *r* on *x* 105° 11′.

About a mile southwest of the Queensborough forge, there is a massive and cleavable variety of a black colour, and having a high lustre. Some specimens closely resemble pyroxene, and perhaps the two minerals pass into each other.

A white lamellar variety is found associated with magnetic iron ore at the Stirling, and at the Forest of Dean mine. It possesses a high vitreous lustre, and is traversed by striæ. The specimen which I analyzed approaches nearly the composition of Thomson's *raphilite;* but our mineral is not fibrous, and is much harder.

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* Gale. *New-York Geological Reports,* 1839.

The variety asbestus is found in fibres from half to three-quarters of an inch in length, near the Greenwood furnace. The same mineral occurs in narrow veins, but of a high silky lustre, at the Stirling, Forshee and O'Neil iron mines. It is found traversing the ore, as well as the accompanying rock. The so called *hard asbestus*, which is found at the Wilks mine in Monroe, and in various parts of the town of Warwick, is probably serpentine.

In the town of Montgomery, the variety byssolite, which is probably a disintegrated hornblende, is found; and the same mineral, with very short fibres, occurs on massive hornblende at what is called *Bedford's gold mine*, in the town of Newburgh.

The town of Warwick is most rich in localities of this mineral.

At the southern base of Mount Eve, two and a half miles north of Edenville, crystallized hornblende is disseminated through an aggregate of limestone and scapolite. The crystals are bluish, greyish green, and deep greenish black. Besides the primary, several other forms have been found at this place.

About a mile north of Edenville is another locality, at which the crystals are of a hair-brown or grey color, associated with sphene, mica and chondrodite, in white limestone. They vary in size from very small to an inch in diameter. From the peculiarity of its colour, it has sometimes been called *Edenite*. A similar variety is found a quarter of a mile south of the preceding, in very large crystals, often six inches long and four inches in diameter. Near this locality, tremolite and hornblende, crystallized and massive, are also found. They are all green of various shades. The crystals are from semi-transparent to transparent.

In the same vicinity, on the farm of B. Hopkins, there is an abundance of grey massive hornblende, containing veins of arsenical iron and other minerals.

The crystalline forms observed at the localities near the village of Amity, are, the primary (Fig. 223), *triunitaire* of Haüy (Fig. 224), *accéléré* of Haüy (Fig. 225), *dodécaèdre* of Haüy (Fig. 226); and also,

Fig. 229, *ditétraèdre* of Haüy, with the additional face *s*.

Fig. 230, prisms very short, but crystals often large and perfect, with one of the terminal planes very small.

Fig. 231, low eight-sided prisms, with only one terminal plane.

Fig. 232, the primary prism with two new terminal planes.

Fig. 229.

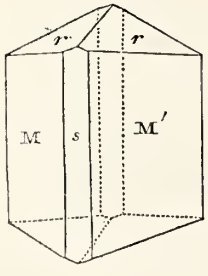

Fig. 230.

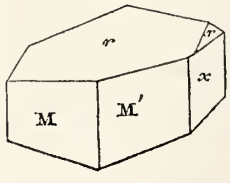

Fig. 231.

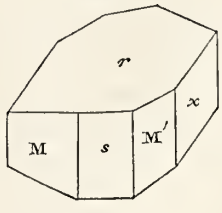

Fig. 232.

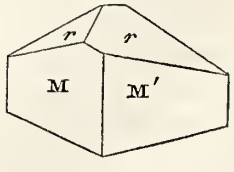

Fig. 233.

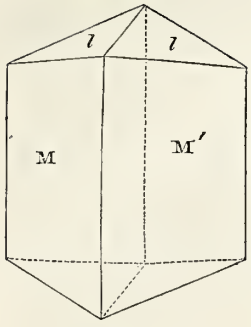

Fig. 234.

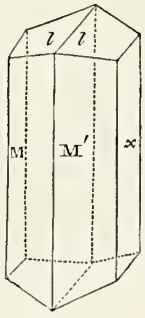

Fig. 235.

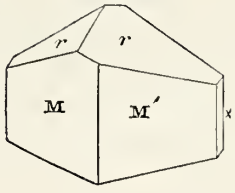

Fig. 233, the same with the terminal planes differing from the preceding: *l* on *l* 110° 2′ (*Shepard*);* *ditétraèdre* of Haüy.

Fig. 234, *bisunitaire* of Haüy.

Fig. 235, prisms low, the face *x* very narrow.

Fig. 236.

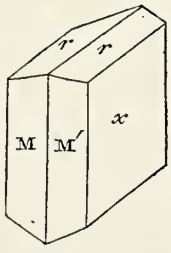

Fig. 237.

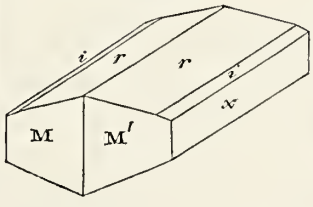

Fig. 238.

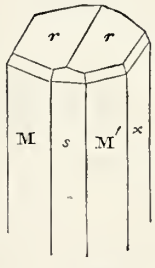

Fig. 236, same as the preceding, with the face *x* much extended.

Fig. 237, the same as the preceding, the face *x* much extended, and with the additional plane *i*: *i* upon *x* 129° 8′.

Also the form represented in Fig. 238.

Near the village of Amity, there are several localities of massive and crystallized hornblende of various colours, and exhibiting a variety of crystalline forms.

The following, in addition to those already introduced, have been found in the town of Warwick, viz:

Fig. 239.

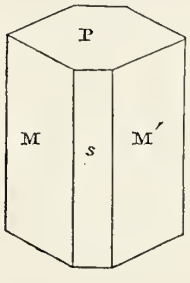

Fig. 240.

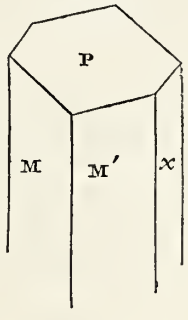

Fig. 241.

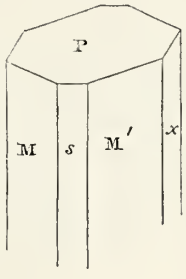

Fig. 239, the primary, with the obtuse lateral edges replaced by tangent planes.

Fig. 240, the same, with the acute lateral edges replaced by tangent planes.

Fig. 241, the same with the obtuse and acute lateral edges replaced by planes.

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* The measurement of *l* on *l*, here given, is from Shepard. Haüy has the angle *l* on *l* 149° 38′ which is the same as *r* on *r*. Crystals with the lesser angle are quite rare in this county.

Fig. 242, the same, with the obtuse and acute latcral edges replaced by two planes.

Also Figs. 243, 244, 245 and 246. k on k 155° 4′; x on z 118° 28′; P on o (Fig. 245), about 152° 30′ (*Horton*).

Fig. 242.

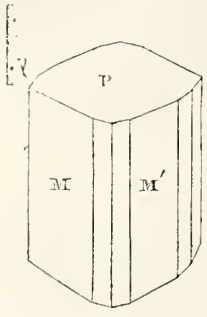


Fig. 243.

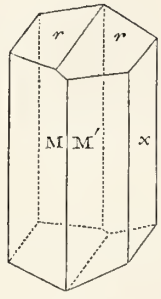


Fig. 244.

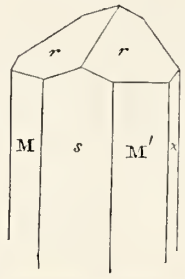


Fig. 245.

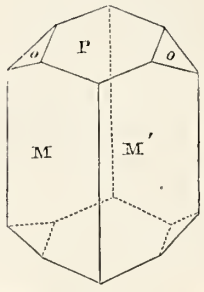
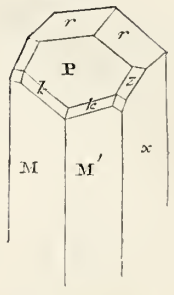


Fig. 246.



There are also various other more highly modified forms at the localities in this town, but they are seldom sufficiently perfect for measurement.

Putnam County. There are several localities of hornblende in this county, but well defined crystals are seldom found.

Hornblende, in the form of the primary with the acute lateral edges replaced by tangent planes (Fig. 240), occurs in Phillipstown, of a grey colour; and tremolite of a white and bluish colour, at Hustis' farm in this town, and also at Coldspring.

Hornblende, in long four and six-sided prisms without perfect terminations, occurs abundantly in a decomposing serpentine at Brown's quarry, three miles northwest of the village of Carmel.

At the same locality, actynolite, of various shades of grey and green, having a good deal of lustre, is found in veins in the serpentine. The fibres are bent, curved and interlaced, and sometimes pass almost into asbestus.

The same variety is found in the town of Kent, about two miles northeast of Carmel.

At the Phillips iron mine, actynolite, green and black, is sometimes found coating the ore.

Lamellar hornblende, having a high lustre, and exhibiting various shades of green, brown and black, is found associated with magnetic iron ore in the town of Southeast, about three miles southeast of the village of Carmel; and the same mineral, of a dark green or black colour, associated with epidote and other minerals, is found in the same town, a short distance from the preceding.

Tremolite of a white and bluish white colour, both bladed and fibrous, is abundant in the dolomite in the vicinity of the village of Patterson. Knapp's quarry affords the best specimens. They are quite similar to those found in the same rock in Dutchess, Westchester and New-York.

Asbestus, often reduced to silky fibres of a white colour, is frequently found in the same rock in the vicinity of Patterson. It is sometimes associated with loose crystals of pyroxene and calcareous spar, the whole having been originally imbedded in the dolomite, which has

crumbled down, and left these crystals and the veins of asbestus exposed. Some barrels of asbestus have been obtained from Rogers' farm, a mile from Patterson. By macerating the specimens in dilute muriatic acid, the dolomite is dissolved, and the asbestus is left in the form of white silky fibres closely interlaced.

The variety amianthus, in thin seams, traverses the serpentine at Hustis' farm in Phillipstown, five miles south of the village of Fishkill, on the stage road to New-York. It is white and yellowish white, and has a beautiful silky appearance. The fibres are fusible by the blowpipe, after coiling at the extremities, into a white opaque mass; they are readily fusible with borax. This mineral has been thought to be identical with the foreign picrolite; but the latter is still an obscure species.

At Cotton Rock, on the bank of the Hudson in Phillipstown, about three and a half miles below West-Point, between high and low water mark, beautiful specimens of asbestus have been obtained. The rocks here, according to Mr. Mather, are impure verd antique, serpentine with diallage rock, augite and granite. Veins of asbestus and delicate silky amianthus pass through the serpentine; the latter having the appearance of cotton or raw silk, has given rise to the name by which this locality is known.*

Richmond County. The varieties, asbestus and amianthus, are very abundant in various parts of this county, especially near the Quarantine. They are found associated with common and steatitic serpentine, and other magnesian minerals. The hard asbestus, resembling chips of wood, occurs near the Pavilion hotel; it breaks into rhombic prisms having the form of hornblende. In the same vicinity there is rose straw-coloured amianthus, having the fibres between two and three feet in length. These fibres have the lustre and softness of silk, and may be spun or woven. As a locality of these varieties, this is one of the best in the United States, and is thought to be equal to any hitherto discovered. It was first made known to mineralogists by Mr. J. Pierce.†

Rockland County. Small but imperfect crystals of black hornblende are common in the trap at Haverstraw, and in other parts of this county. The lamellar variety is abundant at Stony point; and actynolite of a dark green colour, the fibres being radiated, interlaced and imperfectly crystallized, occurs two and a half miles west of Grassy point, associated with a kind of serpentine marble. This locality is often known by the name of *Montagne's marble quarry;* but it is of little value, except for the cabinet specimens which it affords.

Asbestus or picrolite is found in thin veins, associated with the soft serpentine or kerolite, in the trap dyke on the north side of Stony point. It has a greenish colour, a high silky lustre, and the fibres are extremely delicate.

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* Mather. *New-York Geological Reports*, 1839. † *American Journal of Science.* I. 54.

St. Lawrence County. Hornblende, in almost all its varieties, occurs in several parts of this county. Crystals of various shades of green are found in the vicinity of the village of Gouverneur, where they are often associated with apatite, pyroxene, tourmaline, feldspar and quartz. These crystals are sometimes two or three inches in diameter, but are usually short. The forms observed here are similar to those represented in Fig. 244; also Figs. 247, 248 and 249.

Fig. 247.

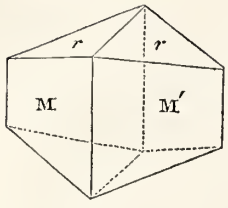


Fig. 248.

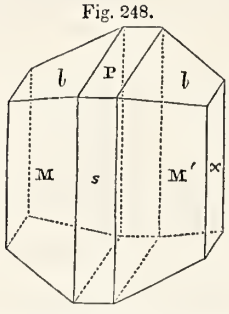
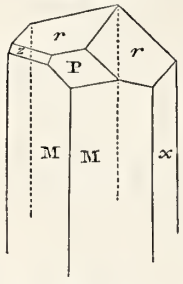


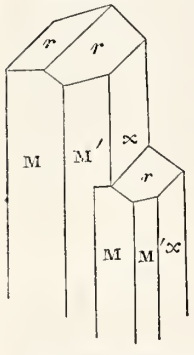
Fig. 249.



Fine crystals have also been obtained in the town of Dekalb. They often have a diameter of two or three inches, but the prisms are short. A very perfect one, in the possession of Dr. Emmons, had the form of Fig. 230. Crystals similar to 234, but with the prisms very short, have also been found in this county.

In the town of Rossie, about two miles north of the village of Oxbow, there is a rock on the road-side, from which beautiful and perfect crystals of the variety pargasite have been obtained. They are of a fine green colour, translucent, and have a high lustre. The associates are pyroxene, feldspar, sphene and apatite. The usual form is the six-sided prism with two terminal planes (Fig. 243); often there are found compound crystals, as represented in Fig. 250. This is one of the most interesting localities in the county.

Fig. 250.



Resplendent hornblende, in large crystals, associated with other minerals, has been found near the bridge at the village of Potsdam; and a white variety, in crystals terminated at each end, sometimes an inch long by three-eighths of an inch in diameter, has been found near Russel.*

On the banks of Yellow lake, in the same town, tremolite of a bluish white colour, and resembling tabular spar, occurs in the white limestone; and the same variety has been found in Gouverneur, and also at Richville and Dekalb, where it is associated with soft pyroxene, brown tourmaline, etc. At the latter locality, it is white and grey, fibrous and bladed.

Tremolite has also been obtained in other parts of the county, and is indeed one of the most common and abundant minerals of the white limestone formation. The asbestus variety occurs in thin veins in the serpentine near the village of Gouverneur, and also near Little York. In the town of Dekalb, it is found in gneiss, and in perpendicular fibres of from a quarter to three quarters of an inch, passing through magnetic iron ore. The latter resembles the byssolite. With this exception, the asbestus heretofore obtained in this county does not possess much interest.

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* Finch. *American Journal of Science.* XIX. 220.

Westchester County. Fine specimens of tremolite, of considerable size, are found in veins in the dolomitic limestone. Thus it occurs at the Eastchester quarries, and at Hastings in the northern part of the county. It is often associated with white pyroxene, and exhibits the peculiarities of the same mineral in Putnam and New-York counties.

The same variety is found at the marble quarries at Sing-Sing; and indeed, wherever the white limestone occurs, this is one of the imbedded minerals.

In the white limestone near Yonkers, the veins of tremolite are sometimes glassy, while it is mixed with pyroxene of a dull white, and the whole is every where penetrated by the dolomite, as is evident from the effervescence which is exhibited when the specimens are subjected to the action of acids. Sometimes these veins traverse a soft serpentine or soapstone.

Near West-Farms, the glassy variety is found in quartz. Tremolite also occurs in the serpentine on the peninsula east of the village of New-Rochelle, and at Rye. At the preceding locality, there are large bowlders, containing abundance of long six-sided prisms of black hornblende, without regular terminations. These have a high lustre. Small crystals, usually imperfect, are found with black mica in quartz on the Croton aqueduct, two and a half miles north of the village of Yonkers.

APPENDIX.

Hornblende pseudomorphs. In the town of Warwick, in Orange county, there occur, in magnesian limestone, crystals having the form and cleavage of hornblende, but which are peculiar in having a soapy feel like steatite, and are often so soft as to be easily cut with a knife. They are usually in the form of six-sided prisms with two terminal planes, resembling Fig. 243, or in that of Fig. 247; but they are sometimes bent and distorted, as if they had been subjected to fusion. The measurements sometimes vary slightly from those of hornblende, but the general form is always the same. Before the blowpipe, they melt with some difficulty into a white glass.

An analysis of one of these crystals gave the following results in 100 parts, viz:

Silica,	35.00
Alumina,	32.33
Lime,	10.80
Magnesia,	20.70

The principal difference in chemical composition between this mineral and several varieties of hornblende, is in the larger amount of alumina which has in part replaced the silica. In a specimen of white tremolite, Bonsdorf found silica 60, magnesia 24, alumina nearly 14. The large proportion of alumina in this and other cases is ascribed by Beudant to the substances which are associated with the hornblende, as spinelle, wernerite, etc.

The limestone in which this soft hornblende occurs, is not, I believe, remarkable for the abundance of spinelle; but a variety of mica, the silvery white, which contains from 34 to 37 per cent. of alumina, is disseminated through it.

This mineral has been ticketed *pyroxene*, *zoisite*, and lastly *kerolite pseudomorphous of hornblende*. The crystalline form, however, is entirely different from either of the two former, and its chemical composition must remove it from the latter. It is most probably a hornblende, altered by an intrusion of alumina and a removal of a part of the silica. The contorted and somewhat fused appearance of many of the crystals clearly point to heat as the agent by which these changes have been produced. The silica which has thus been removed, has combined with the bases of the magnesian limestone, and given rise to other mineral forms. Granular chondrodite and fluor spar are disseminated through the limestone immediately associated with this mineral. May not the chondrodite have been formed by the combination of the silica which these crystals have lost, and the fluor by the decomposition of the mica?

Greyish green mineral. In the same town, and in the same limestone, there are crystals of a greyish green colour, and having the form of long oblique rhombic prisms, with the angles of hornblende.

The hardness of these crystals scarcely exceeds that of talc. They are sometimes slightly translucent. The powder is white. The following are the results of my analysis of a fragment of one of the most perfect crystals, viz:

Silica,	34.66
Alumina,	25.33
Lime,	5.09
Magnesia,	25.22
Water,	9.09

In this case, therefore, there is a little less lime and more magnesia than in the preceding; a difference which is easily explained, as these bodies are isomorphous. The proportion of alumina is also less, but this is made up by the water.

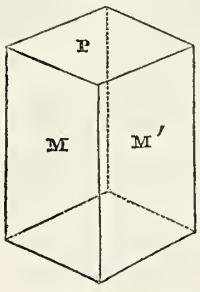
The nature of the changes which have taken place in this mineral, and the causes which have operated to effect them, are probably similar to those just noticed.

ARFWEDSONITE.

[In honor of Professor ARFWEDSON.]

Arfwedsonite. *Phillips.* — Arfvedsonite. *Thomson.* — Peritomer Augit-Spath. *Mohs.* — (Beudant refers to this name as one of the synonyms under his Petalite.)

Fig. 251.



DESCRIPTION. Colour pure black, without a shade of green. Streak greyish green. It has only been observed in cleavable masses. Primary form an oblique rhombic prism.* Fig. 251. M on M′ 123° 55′ (hornblende being 124° 30′). Cleavage parallel with the sides of the prism, producing more brilliant faces than those of hornblende. Lustre resinous. Opaque. Hardness 4.5 (*Thomson*), 6.0 (*Phillips*). Specific gravity from 3.40 to 3.50. Before the blowpipe, it melts easily, with intumescence, into a black globule; with borax, it yields a glass coloured by iron.

COMPOSITION. Silica 50.51, peroxide of iron 35.14, sesquioxide of manganese 8.92, alumina 2.49, lime 1.56, moisture 0.96 (*Thomson.*)

LOCALITIES.

Found at Kargardiuarduk in Greenland, associated with sodalite and eudialite. It was known by the name of *ferruginous hornblende*, until it was shown by Mr. Brooke that the measurements of its crystals did not agree with those of hornblende.

A mineral closely agreeing with the description of arfwedsonite, is found associated with epidote, garnet and magnetic iron ore, in Putnam county, two miles south of the village of Carmel. It has a jet black colour, and is made up of coarse fibres having a high lustre. It is less hard than hornblende. Before the blowpipe, it fuses, with some bubbling, into a black glass, which is powerfully attracted by the magnet.

HYPERSTHENE.

[From the Greek ὑπερ, *above*, and σθενος, *strength;* because it is harder than hornblende, for which it was mistaken.]

Hypersthene. *Haüy, Cleaveland, Phillips, Thomson* and *Beudant.* — Paulite. *Werner.* — Labrador Hornblende. *Kirwan.* — Prismatoidal Schiller Spar. *Jameson.* — Prismatoidischer Schiller-Spath. *Mohs.*

DESCRIPTION. Colour greenish and greyish black; also copper-red and brown. Streak greenish grey. It occurs in lamellar concretions, which have a cleavage parallel with the diagonals and sides of a rhombic prism of about 93° and 87°, (98° 12′ and 81° 48′ according

* Dr. Thomson remarks, that as no cleavages can be observed parallel to the base, we are ignorant whether the prism be right or oblique. *Outlines of Mineralogy, Geology, &c.*

to *Necker.*) Fracture uneven. Lustre bronze-metallic upon the most perfect diagonal cleavage; in other directions, more or less vitreous. Opaque or slightly translucent on the edges. Hardness 6.0. Specific gravity from 3.338 to 3.385. Before the blowpipe it is infusible *per se*, but melts upon charcoal into a greenish grey opaque globule; with borax, it melts into a greenish glass. It is unacted on by acids.

Composition. *Specimen from Labrador*—Silica 54.25, magnesia 14.00, alumina 2.25, lime 1.50, oxide of iron 24.50, water 1.00 (*Klaproth*). It is therefore a silicate of magnesia and iron.

Geological Situation. It is usually found in primitive rocks, especially those of a granitic character. It has also been observed in greenstone.

It may be here remarked, that there is some uncertainty in regard to this mineral. Dr. Köhler of Cassel, some years since, examined several varieties of diallage, and inferred from his analyses that metalloidal diallage, bronzite and hypersthene, are subspecies of pyroxene, and not, like schiller spar and anthophyllite, species of the schiller spar family.* Among these analyses, that of the metalloidal diallage approaches more nearly that of our so called *hypersthene* from Lake George, to be presently noticed, than any other. Mr. J. Phillips expresses the opinion that hypersthene and diallage often differ from each other rather by the crystalline arrangement of the parts, or the substitution of mutually replacing substances, than by any essential and constant characters.†

localities.

Essex County. According to Dr. Emmons, hypersthene is very abundant in what are termed the *granite rocks* of this county. It is associated with labradorite. He does not decide whether it is identical with the hypersthene rock of Dr. MacCulloch; but he says it is as truly one of the constituents of this rock as mica or quartz in the common granite, though not so generally diffused. He also states that the most valuable beds of magnetic iron ore in Essex, and the other northern counties, occur in hypersthene rock.‡

Washington County. A specimen which was obtained from the banks of Lake George in the town of Putnam, and about two miles from Ticonderoga, closely resembles the so called hypersthene from the more northern counties. Its colour is from ash-grey to black. It is foliated and lamellar, and has a pearly or metallic lustre on the cleavage faces. The streak is white. Its hardness is less than that of pyroxene.

The following are the constituents of this mineral, viz:

Silica,	45.45
Lime,	24.33
Magnesia,	18.00
Oxide of iron,	11.49§

* *Brewster's Edinburgh Journal of Science.* IX. 361.

† *Phillips Geology.* II. 63.

‡ Emmons. *New-York Geological Reports*, 1838 and 1840.

§ The above mineral exactly resembles the so called hypersthene from near Wilmington, Delaware. The latter is magnetic.

That the composition of this mineral does not differ essentially from that of some varieties of pyroxene, and of metalloidal diallage, will be evident from the following statement:

Pyroxene, by H. Rose.		Metalloidal Diallage, by Köhler.	
Silica,	54.08	Silica,	51.34
Lime,	23.47	Lime,	18.28
Magnesia,	11.49	Magnesia,	15.69
Protoxide of iron,	10.02	Protoxide of iron and manganese,	8.23
Protoxide of manganese,	0.61	Alumina,	4.39
		Water,	2.11

The true Labrador hypersthene contains, it will be observed, a much smaller proportion of lime (see page 310).

The *Warwickite* of Shepard, which closely resembles hypersthene in its external characters, has been found to contain a large proportion of titanium, and will be therefore described under that metal.

SCHILLER SPAR.

[From the German, signifying *chatoyant spar.*]

Schiller Spar. *Thomson.* — Schiller Spar. *Phillips* and *Shepard.* — Diallage. *Haüy* and *Cleaveland.* — Diatomous Schiller Spar. *Jameson.* — Diatomer Schiller Spar. *Mohs.*

Description. Colour dark green, almost blackish green. Streak yellowish grey. It occurs in broad foliated masses, which cleave in two directions, and apparently have the primary form of a rhombohedron. One of the cleavages is easily obtained, and has a metallic pearly lustre and a pinchbeck brown colour. The laminæ are slightly curved. Fracture uneven, splintery. Lustre metallic pearly on the faces of cleavage. Opaque, and yields to the knife. Sectile. Hardness from 3.5 to 4.0. Specific gravity 3.65. Thin fragments, treated by the blowpipe, are merely rounded on the edges, but become of the same brown colour as when they have been long exposed to the air, and are attracted by the magnet; with borax it is fusible, though with difficulty, and the glass, when cold, has a greenish colour.

Composition. Silica 43.90, magnesia 25.86, protoxide of iron and chromium 13.02, protoxide of manganese 0.53, lime 2.64, alumina 1.28, water 12.43 (*Köhler*).

Geological Situation. This mineral was generally supposed to be found in serpentine; but it appears, from the analysis of Köhler, that the stone in which it occurs is identical in composition with that of the schiller spar.

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fusible by the blowpipe, and according to the analysis of Mr. H. Seybert, contains silica 52.17, lime 20.00, magnesia 11.33, alumina 4.00, deutoxide of iron 10.73, water 1.00. *Cleaveland's Mineralogy*, Appendix.

LOCALITIES.

Putnam County. A mineral closely resembling that described above, is found in a dark coloured serpentine at Brown's quarry, three miles northwest of the village of Carmel. It has a specific gravity of 2.746.

Orange County. A mile south of the village of Amity, there is a mineral associated with chondrodite and serpentine, which bears a close resemblance to schiller spar. It has a dark green colour, a laminated structure, and a metallic lustre. The laminæ are translucent.

There is still some uncertainty in regard to this mineral, and I therefore hesitate to refer to the same species the metalloidal diallage of Haüy. It has already been stated that Dr. Köhler, after an examination of several varieties of diallage, arrived at the conclusion that metalloidal diallage, bronzite and hypersthene, are subspecies of pyroxene, while schiller spar and anthophyllite belong to the schiller spar family. These views in regard to the two latter minerals are adopted by Mohs and Jameson. Dr. Thomson gives a detailed description of the mineral here introduced, which agrees very well with the specimens found in Putnam county.

According to Prof. Shepard, schiller spar is found associated with serpentine and kerolite at Blandford in Massachusetts.

ANTHOPHYLLITE.

[From the Greek ανθος, *a flower*, and φυλλον, *a leaf.*]

Anthophyllite. *Haüy*, *Cleaveland*, *Beudant* and *Shepard.* — Prismatic Schiller Spar. *Jameson.* — Prismatischer Schiller-Spath. *Mohs.* — Anthophyllite, Strelite and Karstin. *Thomson.*

Description. Colour yellowish grey and clove brown. Streak white. It occurs massive, the mass consisting of crystals or crystalline fibres, often disposed in a radiating form ; these may be cleaved parallel to the lateral planes of a rhombic prism of 125° and 55°, and both its diagonals ; but the latter are not brilliant (*Phillips*). Fracture uneven. Lustre pearly, inclining to metallic, especially on the perfect face of cleavages. Translucent on the edges. Hardness from 5.0 to 5.5. Specific gravity from 2.940 to 3.155 (*Thomson*); from 3.00 to 3.30 (*Phillips*). Infusible before the blowpipe *per se ;* with borax, it fuses with difficulty into a glass coloured by iron.

Composition. Silica 56.00, alumina 3.00, magnesia 23.00, lime 2.00, oxide of iron 13.00, oxide of magnesia 4.00 (*Gmelin*) ; Silica 57.12, protoxide of iron 13.52, magnesia 25.92, lime 1.32, water 1.36 (*Thomson*).

Geological Situation. It occurs in primitive rocks.

LOCALITIES.

Putnam County. This mineral is found in the vicinity of Carmel, but the precise locality is unknown. It is of a greyish or brownish white colour, and has the fibres and cleavages of the primary form. The lustre is pearly and somewhat metallic. It is infusible by the

blowpipe, or only at the thin edges, which are rounded, and become of a dark colour; and it may by this character be distinguished from tremolite, which it often resembles. This specimen contains grains and crystals, which are probably chromate of iron.

The mineral called *anthophyllite*, from Rye in Westchester county, is probably tremolite; and the same remark will apply to that found at Smithtown on Long Island.

In Massachusetts, according to Prof. Shepard, this mineral is found at Chesterfield and Blandford, associated with quartz in mica slate; and in Connecticut, with tourmaline and iolite, at Haddam.

HYDROUS ANTHOPHYLLITE.

Hydrous Anthophyllite. *Thomson.* — (Formerly known by the name of Radiated or Stellated Asbestus.)

Description. Colour white, greenish yellow or bluish grey. It occurs in plates, or very imperfect crystals diverging from various centres, or scopiform. The fibres are separable from each other, but more imperfectly than asbestus. Lustre silky. Opaque. Sectile, and has a soft feel. Hardness 2.5. Specific gravity 2.91. Infusible by the blowpipe.

Composition. Silica 54.98, magnesia 13.38, peroxide of iron 9.83, protoxide of manganese 1.20, potash 6.80, alumina 1.56, water 11.45 (*Thomson*).

LOCALITIES.

Dutchess County. There is a locality of this mineral in the town of Fishkill, about five miles southeast of Stormville, on the land of Mr. Peck. It occurs in fibres forming radiated masses of a white and bluish grey colour, in a talcose rock.

New-York County. Hydrous anthophyllite has been found in place on the west side of the island, between the 10th avenue and the Hudson, and between 57th-street on the south and 63d-street on the north. Here the strata are nearly vertical; the width of the bed at right angles to the strike, varying from three to thirty rods. Dr. Gale states that the granite lying on the west, and the gneiss on the east of the rock in question, come in complete contact with it without intermixing.*

This mineral is also found in bowlders in various parts of the island. The fibres are sometimes long and parallel; at others, short and radiated or interlaced. The true composition of this mineral was first pointed out by Dr. Thomson, who received his specimens from New-York.

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* *New-York Geological Reports*, 1839.

ORDER II. ALUMINA.

I. *Minerals in which the alumina is nearly pure, or combined with an acid.*

1. Corundum.
2. Spinelle.
3. Automalite.
4. Gibbsite.
5. Aluminite ?

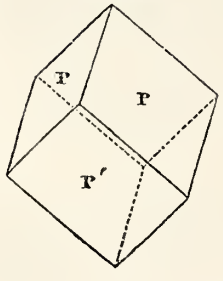
II. *Minerals chiefly composed of silica and alumina, combined with some alkali, alkaline earth or metallic oxide.*

6. Idocrase.
7. Garnet.
8. Scapolite.
9. Staurolite.
10. Feldspar.
11. Labradorite.
12. Albite.
13. Stellite.
14. Mesotype.
15. Stilbite.
16. Heulandite.
17. Epistilbite.
18. Apophyllite.
19. Prehnite.
20. Thomsonite.
21. Laumonite.
22. Analcime.
23. Chabazite.
24. Epidote.
25. Tourmaline.
26. Clintonite.
27. Andalusite.
28. Bucholzite.
29. Kyanite.
30. Achmite ?
31. Pitchstone.
32. Spodumene.
33. Pyrophyllite.
34. Mica.

CORUNDUM.

Corindon. *Haüy* and *Beudant.* — Corundum. *Cleaveland* and *Shepard.* — Sapphire. *Thomson.* — Rhombohedral Corundum. *Jameson.* — Rhomboedrischer Korund. *Mohs.*

Fig. 252.



Description. Colour blue, red, grey, white, green, yellow, brown and black. Streak white. It occurs regularly crystallized; also massive. The primary form is a rhombohedron. Fig. 252. P on P 86° 6′; P on P′ 93° 54′. Fracture conchoidal and uneven. Lustre vitreous, sometimes inclining to adamantine. Transparent to feebly translucent on the edges. Hardness 9.0. Specific gravity from 3.97 to 4.16. Infusible by the blowpipe; with borax, it fuses slowly but perfectly into a colourless glass. It is not acted on by acids. Becomes electric when rubbed.

Varieties. *Sapphire.* This name is applied to the transparent blue varieties.

Oriental Ruby, is transparent, and of a blood-red or rose-red colour.

Emery. Massive; nearly opaque; bluish grey and greyish black.

Common Corundum. Massive and crystallized; of various colours; translucent.

Adamantine Spar. This is brown and faintly translucent.

Composition. *Sapphire*—Alumina 98.50, oxide of iron 1.00, lime 0.50 (*Klaproth*).

Emery—Alumina 86.00, silica 3.00, lime 3.00, oxide of iron 4.00 (*Tennant*). In its pure form, therefore, this mineral is an oxide of aluminum, the formula of which, according to Kane, is Al_2O_3.

Geological Situation. The finest sapphires and rubies occur in alluvial soil in Ceylon, &c. Common corundum and adamantine spar are said to be found at foreign localities, in granite. In this State, and in New-Jersey, corundum has heretofore been found only in white limestone.

Uses. The transparent varieties are highly esteemed as gems. The common corundum, and emery, are employed for polishing steel, cutting gems, etc.

Fig. 253.

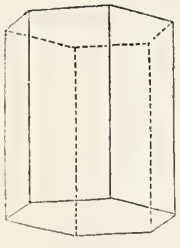
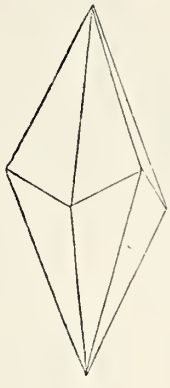


Fig. 254.



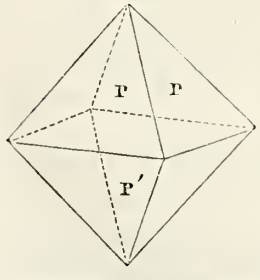
LOCALITIES.

Orange County. Corundum has been found, by Dr. Horton, in the vicinity of the village of Amity. The colours are nearly white, pale and deep blue, and pale and deep rose-red. It occurs in crystals and grains. Fig. 253 and 254 represent two of the forms which have been observed, but the sides are rough, and cannot be well measured. It is associated with hornblende, spinelle and red oxide of titanium, in white limestone. This mineral is also found at Newton in New-Jersey.

SPINELLE.

Spinelle. *Cleaveland* and *Beudant.* — Spinell. *Thomson.* — Spinel. *Phillips, Shepard* and *Dana.* — Dodecahedral Corundum, or Spinel. *Jameson.* — Dodecaedrischer Korund. *Mohs.*

Fig. 255.



Description. Colour red, sometimes green, black, blue, yellow, brown, and nearly white. Streak white. It occurs regularly crystallized. The primary form is a regular octahedron. Fig. 255. P on P′ 109° 28′ 16″ (*Haüy*). Cleavage parallel with the primary from difficult. Fracture conchoidal. Lustre splendent and vitreous. Form transparent to translucent on the edges. Hardness 8.0. Specific gravity from 3.50 to 3.60. Infusible by the blowpipe alone; with borax, it fuses slowly into a transparent glass. The solution obtained by an acid after treatment with caustic potash, affords a precipitate of alumina after the addition of hydrosulphate of ammonia.

Varieties. *Ceylonite* or *Pleonaste*. This includes the dark green and black crystals, which are translucent only on the edges. The other varieties are called *Spinelle* or *Spinelle Ruby*.

Composition. *Red Spinelle*—Alumina 74.50, silica 15.56, magnesia 8.25, oxide of iron 1.56, lime 0.75 (*Klaproth*).

Black Spinelle from Amity, Orange county—Alumina 61.79, silica 5.59, magnesia 17.87, protoxide of iron 10.56, lime 2.80, water 0.98 (*Thomson*).

Geological Situation. In this State, spinelle is almost exclusively found in the white limestone. It is frequently associated with other minerals. In other countries, it is usually found in the sands of rivers.

Use. Some of the varieties of spinelle are esteemed as gems.

LOCALITIES.

Jefferson County. Crystals of a light blue colour, associated with plumose mica, are found in white limestone, two and a half miles southwest of the village of Oxbow in the town of Antwerp. Similar ones have also been found in the immediate vicinity of the village. The largest that have been observed, are half an inch in diameter. The forms are the primary (Fig. 255); the primary with the edges truncated, *émarginé* of Haüy, Fig. 256, P on *o* 144° 48′ 8″, *o* on *o* 120°; the same with two opposite edges truncated, Fig. 257; and the same, having four opposite sides extended so as to present the appearance of an octahedron with a rectangular base, Fig. 258.

Fig. 256.

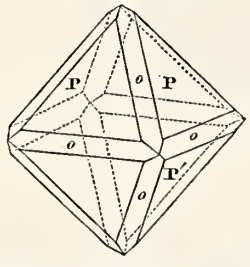


Fig. 257.

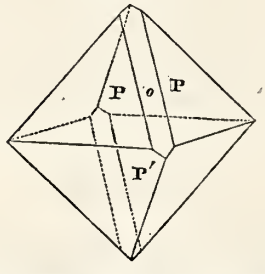
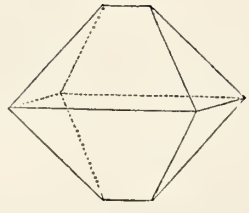


Fig. 258.



Orange County. Spinelle of various colours has been found more abundantly in this county, than in any other part of the world. The specimens are sometimes also remarkable for size, as they have been obtained measuring sixteen inches round the base. They are most commonly associated with brucite, and I believe invariably occur in white limestone.

In the town of Cornwall, four miles west of West-Point, it occurs in black and green octahedrons, thickly disseminated in white limestone.

In the town of Monroe, in the Forest of Dean, at the Natural bridge, in the vicinity of Greenwood furnace on Duck-cedar pond, and at the so called Silver mine, the black and green varieties are found. They generally have the primary form.

In the town of Warwick the localities are almost innumerable, although it is by no means easy to obtain large or fine specimens at the present day.

Near the village of Amity, it occurs of a greenish black to purplish grey colour. A mile southwest of this, on the farm of I. Layton, is a locality remarkable for the number, variety and large size of the crystals which have been procured. The colours are black, greyish black, bluish black, and reddish brown; the black, however, being the most abundant. The crystals are usually very perfect, but sometimes exhibit the octahedral form of the molecules of which they are made up, a kind of dissection having taken place. They are associated with serpentine, chondrodite and crichtonite.

Half a mile north of the preceding, spinelle occurs in greyish red octahedrons, and in twin crystals.

About half a mile south of the village of Amity, the brown variety has been found. Dr. Heron has an imperfect crystal from this locality, weighing fifty-nine pounds.

A mile north of this village, on the farm of W. Raynor, black spinelle is found in grouped and twin crystals.

There are also numerous other localities in the immediate vicinity of the village of Edenville, in this town. For these, I must refer to the Catalogue of Dr. Horton.*

The following crystalline forms have been found in this town, viz. Fig. 259; the grouped crystals, Fig. 260 and 261;

Fig. 259.

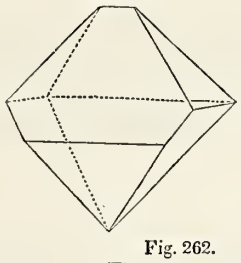


Fig. 260.

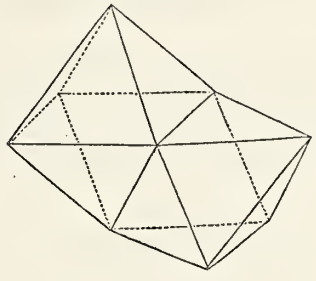


Fig. 261.

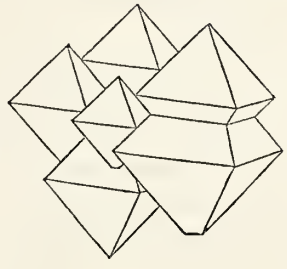


Fig. 262.

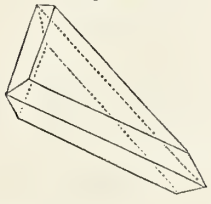


Fig. 263.

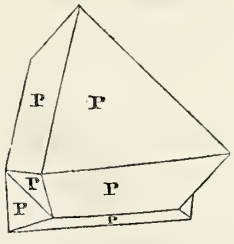
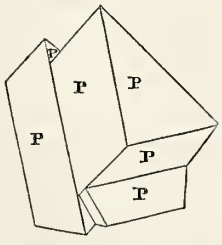


Fig. 264.



The twin crystal, Fig. 262, consisting of two equal and similar portions of a crystal resembling Fig. 256, being sections parallel with two opposite primary planes applied base to base;

Fig. 263, composed of about equal parts of the primary octahedron, of which one-half is turned round;

Fig. 264, in which three nearly equal parts of the same crystal are variously turned upon each other. The face of composition, in the latter case, projects.

* *New-York Geological Reports*, 1839.

St. Lawrence County. Spinelle of a light blue colour, and having the primary form, occurs associated with chondrodite, about two miles north of the village of Somerville in the town of Rossie. The crystals, however, are quite small.

It is a singular fact, that while spinelle is so very abundant in various parts of Orange county, it should be so rarely met with in the similar formations in the northern parts of the State. Although it is found in the counties of Jefferson and St. Lawrence, and, according to Dr. Emmons, also in the counties of Essex and Warren, the crystals are often minute, and always, as hitherto observed, sparingly disseminated; so that it may be still said to be rare in Northern New-York.

APPENDIX.

Soft Spinelle. There is a mineral found in the town of Warwick in Orange county, which is of a black colour, and has the crystalline form of spinelle. It is imbedded in a gangue of dark coloured soft serpentine. The octahedral crystals are so soft that they can be easily scratched with a knife, and reduced to a coarse powder; but the powder, which is of a grey colour, is gritty, and is with difficulty rendered impalpable.

This mineral has passed under the names of *kerolite pseudomorphous of spinelle*, *pseudolite*, etc., which have been employed to express the supposed chemical constitution and the crystalline form.

In conducting the analysis of this mineral, I found that a large proportion of the powder resisted two or three ordinary fusions with carbonate of soda. This led me to suspect that it might contain a portion of real spinelle, instead of its being, as I had supposed, entirely made up of serpentine or some similar mineral. The correctness of this view was confirmed by subsequent examinations.

The composition of these crystals is nearly as follows, viz:

Silica,	19.07
Alumina,	35.00
Oxide of iron,	9.97
Magnesia,	28.58
Water,	7.33

If now we take about 17 parts of the silica, 15 of magnesia, 6 of water, and 2 of oxide of iron, they will produce about 40 per cent. of serpentine, and the remaining constituents will be nearly in the proportion in which they are found, according to the most trustworthy analyses, to occur in spinelle.

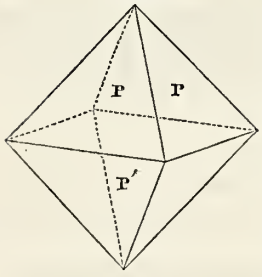
The peculiarity of these crystals is therefore to be referred to the intrusion of the serpentine into the crystals of spinelle, a part of which has been removed. And although the crystals are softer than might be supposed from their composition as above stated, it is quite probable, that during the process of substitution, the cohesion of all the particles has been impaired, so as to bring about the apparent softness of the crystals, while the particles are really so hard, as they prove to be when subjected to the action of the pestle.

AUTOMOLITE.

[From the Greek αυτομολος, a *deserter;* on account of the presence of the oxide of zinc.]

Automolite. *Phillips* and *Thomson.* — Gahnite. *Cleaveland* and *Beudant.* — Spinelle Zincifère. *Haüy.* — Octahedral Corundum. *Jameson.* — Octaedrischer Korund. *Mohs.*

Fig. 265.



Description. Colour muddy dark blue, passing into blackish green. Streak white. It occurs regularly crystallized. Primary form a regular octahedron, Fig. 265. Cleavage parallel with the primary faces. Fracture conchoidal. External lustre pearly, inclining to semi-metallic; internally, shining and resinous. Opaque, or faintly translucent on the edges. Hardness 8.0. Specific gravity from 4.23 to 4.70. Before the blowpipe it is unalterable alone, and nearly so with salt of phosphorus or borax. When the mineral is subjected to heat with caustic potash, and treated with an acid, the alumina is precipitated by ammonia. From this solution, oxide of zinc is again precipitated, when it is saturated by an acid.

In its crystalline form, automolite resembles spinelle; but it differs in being heavier, in having a different colour, and especially in containing a large proportion of oxide of zinc.

Composition. *A specimen from the United States*—Alumina 57.09, silica 1.22, oxide of zinc 34.80, magnesia 2.22, protoxide of iron 4.55 (*Abich*).

Geological Situation. It is usually found in primitive rocks.

LOCALITIES.

St. Lawrence County. Automolite has been credited to the village of Rossie, where it was said to have been found in minute octahedrons, in calcareous spar.* I am inclined to believe, however, that the mineral here referred to is common spinelle. It is introduced among the New-York minerals on the above authority, and for the purpose of directing the inquiries of our mineralogists to the subject.

According to Shepard, it occurs at Haddam in Connecticut, where it is associated with chrysoberyl, garnet and columbite, in granite.

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* Finch. *American Journal of Science.* XIX. 220.

GIBBSITE.

[In honor of the late Col. George Gibbs.]

Gibbsite. *Cleaveland, Phillips, Shepard, Dana, Beudant, Mohs* (App. 1614). — Gibbsite, or Hydrate of Alumina. *Thomson.*

Description. Colour white, with a slight shade of green or grey. Streak white. It occurs in reniform, botryoidal and stalactitic masses. Composition fine granular. Lustre dull. Slightly translucent. Hardness from 3.0 to 3.5. Specific gravity from 2.40 to 2.09. Infusible by the blowpipe, but gives out water.

Composition. Alumina, 64.80, water 34.70 (*Torrey*). Formula Al_2O_3+Aq.

Alumina 54.91, silica 8.73, peroxide of iron 3.93, water 33.60 (*Thomson*). The latter supposes it to consist of a congeries of hydrates.

Geological Situation. This mineral has heretofore been found only in beds of hematitic iron ore.

LOCALITIES.

Dutchess County. Gibbsite has been found in considerable abundance, investing hematite at the Clove mine in the town of Union-vale. It is of a white or yellowish white colour, and occurs in tuberose masses or stalactites which are slightly fibrous. Specific gravity, the mean of two trials with specimens as pure as I could obtain, 2.305. The mineral is easily reduced to powder, but it is tough, and some parts of it are much harder than others. It is soluble in muriatic acid without effervescence. My specimen contained silica and oxide of iron, but these may be accidental ingredients, as it is exceedingly difficult to free the specimens from hematite.

This mineral was first discovered by Dr. Emmons, in a neglected mine of brown hematite at Richmond in Massachusetts. Dr. Horton informs me that he has recently found it in Orange county. These are the only known localities.

ALUMINITE.

Subsulphate of Alumina. *Cleaveland? Phillips.* — Websterite. *Beudant?*

Description. This mineral occurs in reniform masses and botryoidal concretions, of a white or yellowish white colour. Fracture earthy. Adheres to the tongue. Specific gravity 1.66. It gives out water by calcination. Fuses with difficulty by the blowpipe. Soluble in acids without effervescence. The solution gives with ammonia a gelatinous precipitate, which is redissolved by pure potash or soda.

Composition. *Specimen from Halle in Prussia*—Alumina 30.26, sulphuric acid 23.36, water 46.33 (*Stromeyer*).

LOCALITIES.

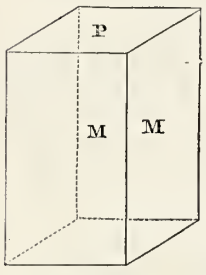
This mineral has been found in clay near New-Haven in Sussex, Eng.; at Epernay in France, and at Halle in Prussia. It is believed to occur in the clay on Staten island, and elsewhere in this State. Indeed many of our clays and slates, which contain iron pyrites, are covered with incrustations or effloresences of the sulphate of alumina. I am not certain, however, whether the mineral thus found belongs to the present species, or to the *sulphate of alumine* of Boussingault and Phillips, the *alunogène* of Beudant, as I have not had an opportunity to analyze it. It is probably more common than has been supposed, but may have been confounded with alum, for the manufacture of which it may be advantageously employed, as it is only necessary to add potash to the solution of this salt.

IDOCRASE.

[From the Greek ειδω, *I see*, and κρασις, *mixture;* because its crystals resemble those of several other minerals.]

Idocrase. *Haüy, Cleaveland, Thomson, Phillips, Beudant* and *Shepard.* — Pyramidal Garnet. *Jameson.* — Pyramidaler Granat. *Mohs.* — Vesuvian, and Egeran. *Werner.*

Fig. 266.



Description. Colour green, brown, and rarely blue. It occurs regularly crystallized; also massive and disseminated. Primary form a right square prism, Fig. 266. Cleavage parallel with M, and also with P, but less distinct. Fracture uneven, inclining to small conchoidal. Lustre vitreous, or vitreo-resinous. From transparent to translucent on the edges. Hardness 6.5. Specific gravity from 3.00 to 3.45. Before the blowpipe, it is fusible with ebullition into a yellowish or greenish translucent globule; with borax, it forms a diaphanous glass tinged green by iron.

From the experiments of Klaproth, Von Kobell and Magnus, it appears that idocrase and garnet have the same chemical composition. They differ, however, in their crystalline form, and this will probably afford the best means of distinguishing these two minerals. Chrysolite, olivine and zircon are infusible.

Composition. Silica 38.85, alumina 21.93, lime 33.61, oxide of iron 5.40 (*Kobell*). It is probably a compound of the silicate of alumina and lime.

Geological Situation. This is one of the minerals frequently thrown out by volcanoes. In the State of New-York, it is found only in primitive rocks, especially in white limestone.

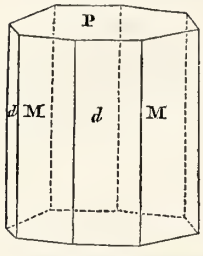
LOCALITIES.

Essex County. Prof. Shepard notices the occurrence of idocrase near Port Henry. He describes it as having a dark reddish-brown colour, and being in masses of considerable size, one of which was obtained, presenting several crystalline faces. It was said to be associated

with iron pyrites, calcareous spar and dark brown hornblende.* I have diligently searched for this mineral at the locality just mentioned, but have not succeeded in obtaining specimens of it. The brown tourmaline is quite abundant in the white limestone, and it is possible that it may have been mistaken for idocrase.

This mineral has been found, by Dr. Emmons, in carbonate of lime at Long pond.

Fig. 267.



Jefferson County. On Muscolunge lake, in the town of Antwerp, four miles northwest of Oxbow, this mineral occurs in light yellow crystals, associated with crystallized mica, in white limestone. Some of these crystals are similar to the *périoctaèdre* of Haüy, Fig. 267, M on *d* 135°; others have modified terminations, but they are too imperfect to be determined.

Orange County. This mineral occurs in grains, crystals and crystalline masses, near the village of Amity in the town of Warwick. The granular variety is probably that which was analyzed by Dr. Thomson, and described by him as a new mineral under the name of *Xanthite*. The colours are yellow and greenish yellow. Of the crystalline forms, there are the *périoctaèdre* of Haüy (Fig. 267), and another highly modified crystal, too imperfect for description. Some of the lateral planes are striated. The crystalline masses, according to Dr. Horton, are not unfrequently from six to ten inches in diameter.

In regard to the xanthite, it may be remarked that there is still a difference of opinion. It is usually placed under idocrase, with which the analysis of Dr. Thomson agrees very well. It is as follows:

Silica,	35.09
Lime,	33.08
Alumina,	17.43
Peroxide of iron,	6.37
Protoxide of manganese,	2.80
Magnesia,	2.00
Water,	1.68†

On the other hand, Mr. Mather states that it exhibits cleavages parallel to the faces of an oblique rhomboidal prism.‡ The specific gravity is from 3.201 to 3.221. It is fusible by the blowpipe, according to my trials, into a greenish bead. In my opinion, it is identical with idocrase. Its associates are hornblende, apatite, etc.

About half a mile south of the village of Amity, crystallized idocrase occurs of a greyish and yellowish brown colour, in white limestone. There is another locality about a mile east

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* Shepard. *American Journal of Science.* XVII. 140.

† Thomson. *Outlines of Mineralogy, Geology, &c.*

‡ *American Journal of Science.* XVIII. 359.

Fig. 268.

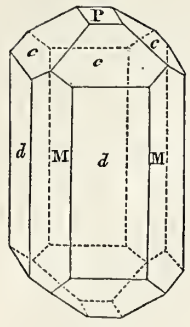
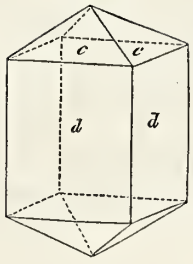


Fig. 269.



of the same village. Crystals resembling the *unibinaire* of Haüy, Fig. 268, but having the planes M much narrower than in his figure; and also those similar to Fig. 269, have been found here by Dr. Horton. M on *d* 135°; M on *c* 115° 15′; P on *c* 142° 54′; *c* on *d* 127° 6′.

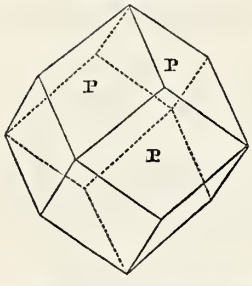
At Worcester in Massachusetts, idocrase is found, closely resembling the specimens from Eger in Bohemia. It is in seams and veins in a quartz rock, and is associated with pyroxene and garnet.

GARNET.

[From the French, referring to the colour of pomegranate seeds.]

Garnet. *Cleaveland, Phillips, Shepard* and *Dana.* — Grenat. *Haüy* and *Beudant*, (the latter makes it a subgenus, including several species usually considered as varieties, viz. Grossulaire, Almandine, Melanite, and Spessartine.) — Dodecahedral Garnet. *Jameson.* — Dodecaedrischer Granat. *Mohs.*

Fig. 270.



Description. Colour red, brown, green, black, grey and yellow. It occurs regularly crystallized; also massive. Primary form a rhombic dodecahedron. Fig. 270. P on P 120°. Cleavage parallel with the dodecahedron, but imperfect. Fracture conchoidal, splintery, uneven. Lustre vitreous, inclining to resinous. From transparent to opaque. Hardness from 6.5 to 7.5. Specific gravity from 3.35 to 4.24. Before the blowpipe, garnet generally melts, with little or no effervescence, into a dark coloured globule, having a vitreous lustre, and which is often attracted by the magnet.

An examination of the crystalline forms will probably afford the best means of distinguishing garnet from the other minerals which it resembles. Hyacinth and leucite differ in being infusible; while idocrase, which it often resembles, easily melts into a shining yellow glass.

Under the general name of *garnet*, are now usually included several minerals which, although they differ considerably in some of their characters, are principally composed of the same constituents, but in variable proportions. They agree so far, that all those which are regularly crystallized occur in the rhombic dodecahedron and its varieties. It is quite probable, however, that some of these varieties will hereafter be found to possess specific differences.

Varieties. *Common Garnet.* The colour of this variety is some shade of brown. It is opaque or only translucent, in which it differs from *Precious garnet.* It is found crystallized and in granular masses; sometimes it has a lamellar structure.

Precious Garnet — Almandine. This is usually some shade of red, often beautiful. It is commonly translucent, often transparent. It occurs crystallized, has a conchoidal fracture, and a shining vitreous lustre.

Pyrenaite ,or *Pyreneite*. Black or greyish-black and opaque. It occurs in small dodecahedral crystals, which externally have a metallic-like aspect.

Aplome. Resembles garnet in aspect and external form, but differs in having its planes striated parallel with their lesser diagonal; which, according to Haüy, indicates the cube as its primary.

Grossular, or *Grossulaire*. Of an olive green colour; translucent or semitransparent, and occurring in trapezoidal or leucite-formed crystals.

Magnesian Garnet. Occurs massive, and in dodecahedral crystals variously modified. It is slightly translucent on the edges, and has a deep hyacinth or brownish red colour. It contains a large proportion of the protoxide of manganese.

Melanite. This includes the velvet-black, opaque specimens. It occurs in rhombic dodecahedrons, whose edges are often replaced. Before the blowpipe, it yields a brilliant black globule.

Colophonite—Garnet Resinite. This is composed of rounded grains of various sizes, which may be easily separated. It is of a brown, red or yellow colour, and has a high resinous or resino-adamantine lustre.

Allochroite. It has a greyish, dingy yellow or reddish colour; a glimmering lustre, and feeble translucency. It is massive, and has an uneven fracture.

Pyrope. This variety occurs in roundish or angular grains of a deep blood-red colour, and perfect transparency.

Topazolite—Yellow Garnet. This has a topaz-yellow colour: translucent or transparent. Occurs crystallized.

Essonite, or *Cinnamon Stone*. Occurs in granular distinct concretions, and massive. It is of a hyacinth or orange-yellow colour; transparent or translucent; has a resino-vitreous lustre, and a conchoidal fracture. Phillips describes this as a distinct species.

Chemical Composition. This is of course somewhat different in the different varieties.

Almandine from New-York—Silica 42.51, alumina 19.15, protoxide of iron 33.57, oxide of manganese 5.49 (*Wächtmeister*).

Precious Garnet—Silica 35.75, alumina 27.25, oxide of iron 36.00, oxide of manganese 0.25 (*Klaproth*).

Pyrenaite—Silica 43.00, alumina 16.00, lime 20.00, oxide of iron 16.00, water 4.00 (*Vauquelin*).

Aplome—Silica 35.64, lime 29.22, oxide of iron 30.00, oxide of manganese 3.01, potash 3.25 (*Wächtmeister*).

Grossular—Silica 40.55, alumina 20.10, lime 34.86, oxide of iron 5.00, oxide of manganese 0.48 (*Wächtmeister*).

Manganesian Garnet—Silica 35.83, alumina 18.06, protoxide of iron 14.93, protoxide of manganese 30.96 (*Seybert*).

Melanite—Silica 35.5, alumina 6.00, lime 32.50, oxide of iron 25.25, oxide of manganese 0.40 (*Vauquelin*).

Colophonite—Silica 37.00, alumina 13.50, lime 29.00, oxide of iron 7.50, oxide of manganese 4.80, magnesia 6.50, water 1.00 (*Simon*).

Allochroite—Silica 35.00, alumina 8.00, lime 30.00, oxide of iron 17.00, oxide of manganese 3.50 (*Vauquelin*).

Pyrope—Silica 40.00, alumina 28.50, lime 3.50, oxide of iron 16.50, oxide of manganese 0.3, magnesia 10.00, chromic acid 2.60 (*Klaproth*).

Topazolite—Silica 37.00, alumina 2.00, lime 29.00, glucina 4.00, oxide of iron 25.00, oxide of manganese 2.00 (*Bonvoisin*).

Essonite or *Cinnamon Stone*—Silica 38.80, alumina 21.26, lime 31.25, oxide of iron 6.50 (*Klaproth*).

Geological Situation. Garnet, in all its varieties, is most commonly found in primary rocks. Those which, in this State, afford the best specimens, are gneiss and mica slate, the latter of which is often thickly studded with the dodecahedral crystals. It is sometimes found in white limestone, but I am not aware that any of the varieties have been here observed in the transition rocks.

LOCALITIES.

Dutchess County. Near the Foss ore bed in the town of Dover, crystallized garnet occurs abundantly in mica slate. The colours are red and dark brown, and sometimes the crystals are translucent. They are usually small, very seldom exceeding the size of a pea, and occasionally associated with staurolite. The forms are the primary (Fig. 270); the primary with the edges replaced by tangent planes, *émarginé* of Haüy, Fig. 271, P on *n* or *n'* 150° 0′, *n* on *n* or *n'* on *n'* 131° 48′ 36″, *n* on *n'* 146° 26′ 33″; the same with six of the sides extended, giving it the appearance of a six-sided prism, and with two other sides assuming a hexagonal outline, Fig. 272; also Fig. 273, in which six of the primary planes are extended, and all the edges are replaced by tangent planes.

Fig. 271.

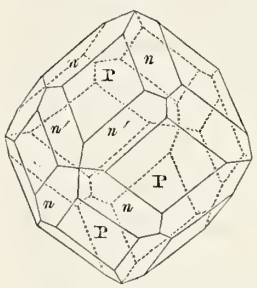


Fig. 272.

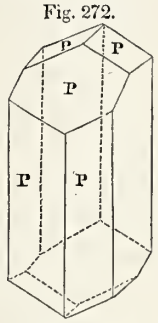
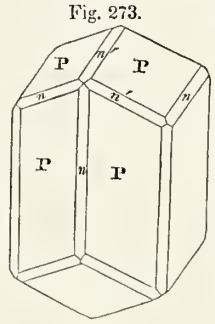


Fig. 273.



At Stone church, in the same town, is another similar locality of garnet in a light coloured mica-slate. The crystals are in great abundance, and are similar in form to those observed at the Foss ore bed.

Essex County. In the town of Willsborough, nine miles northwest of the village of Essex, there is a detached mountain mass, which extends from east to west; and on its northern face, near the base, is a bed of the variety colophonite in gneiss. The bed is from two to five feet in width, and the mineral is made up of large grains of red, yellow and deep brown colours, which have a high resinous lustre, and are frequently irised; the single grains are highly translucent, and have a cleavage. Specific gravity 3.896. It is associated with the massive

and granular varieties of garnet, tabular spar, green coccolite, and occasionally with crystallized hornblende. This locality was first described by Mr. A. E. Jessup.*

The composition of this colophonite, according to Mr. H. Seybert, is as follows: †

Silica,	38.00
Lime,	29.00
Protoxide of iron,	25.20
Alumina,	6.00
Water,	0.33

A similar locality exists in the town of Lewis, about ten miles south of the village of Keeseville. The specimens can scarcely be distinguished from those obtained from Willsborough. It is, like that just described, an immense deposit of colophonite in large grains, associated with, and apparently passing into, massive garnet of various colours. It is also associated with tabular spar, which, as well as the garnet, is very abundant.

Several varieties of garnet are found in great abundance at the celebrated Rogers' rock. These, however, constantly pass into each other by almost imperceptible shades, and sometimes several of them are found in a mass of one or two feet in diameter. In some parts of the deposit, the garnet is in the form of red grains and irregular masses, associated with white feldspar; in others, the grains are small, loosely aggregated, have a high lustre, and a reddish yellow colour. This, together with similar grains of a beautiful red colour, belongs to the colophonite variety. Huge masses of a yellowish and reddish yellow colour, and which cleave into plates, are also abundant; and in the fissures in this variety, interesting crystalline forms are often found. These crystals have a peculiarly resinous lustre, and a paler colour than is usual. The forms observed are the primary (Fig. 270); the primary with the edges replaced by tangent planes (Fig. 271); also the forms represented by Fig. 272, and by Fig. 274, in which six of the faces of the dodecahedron are so much extended as to give the crystal the appearance of a six-sided prism with three terminal planes; Fig. 275, in which two of the sides are so much enlarged as to present the form of a flattened table; and also Figs. 276 and 277.

Fig. 274.

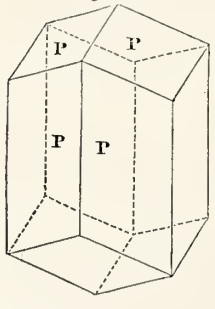


Fig. 275.

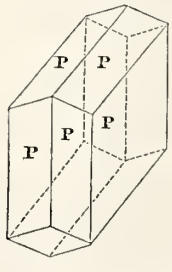


Fig. 276.

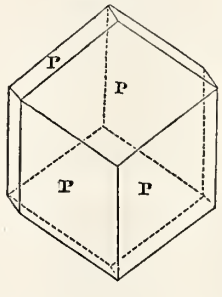
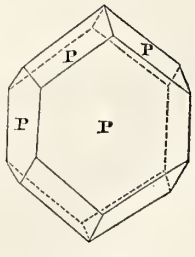


Fig. 277.



* *Journal of the Academy of Natural Sciences of Philadelphia.* II. 185.

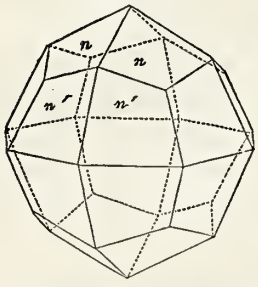
† *American Journal of Science.* V. 118.

The garnet at this locality is sometimes associated with minute, loosely aggregated crystals of calcareous spar, and with coccolite.

According to Dr. Emmons, crystallized brown garnet occurs in the town of Crown-Point, and other varieties are found at Long pond.

Montgomery County. Garnet of a pink colour is abundantly disseminated in the gneiss and granite in the town of Palatine, about two miles southeast of Spraker's basin. It is in small grains and dodecahedrons, which usually have the edges rounded.

Fig. 278.



New York County. Brown garnet, with twenty trapezoidal faces (Fig. 278), usually quite imperfect, is abundant in the gneiss on the banks of the Hudson between 42d and 50th-streets, and in bowlders in every part of the island.*

Oneida County. Brown granular garnet occurs in the bowlders which are so abundantly met with in the vicinity of Boonville. It is associated with tabular spar and green pyroxene.

Orange County. There are several localities of garnet in this county, but it is usually granular or massive.

Near Amity, it is found of a reddish colour. About a mile and a quarter southwest of the same village, it is of a cinnamon colour, and is occasionally crystallized. In this vicinity, also, it occurs in crystals of a pale and deep red and wine-yellow colour, which, although usually small, are sometimes several inches in diameter. The yellow ones are very perfect and transparent, and exactly resemble the variety from Fassa in the Tyrol. Some of the granular specimens are scarcely to be distinguished from those from Rogers' rock in Essex county. Of the crystalline forms here observed, there are the primary (Fig. 270), and the modification (Fig. 271).

At the O'Neil iron mine, in the town of Monroe, garnet occurs in the form of imperfect crystals and grains of a red colour, in granite.

About four miles west of Southfield furnace, in the same town, the variety colophonite is found associated with magnetic iron ore. It consists of very small grains, which are red, reddish brown and almost black, and very brilliant. Before the blowpipe, it fuses with effervescence into a shining black bead, which is slightly magnetic.

Saratoga County. In the town of Greenfield, about a mile north of Saratoga Springs, crystallized garnet is found associated with tourmaline, chrysoberyl, etc., in a vein of granite. The crystals have trapezoidal faces (Fig. 278), and are of a reddish brown colour. They sometimes half an inch in diameter, but are seldom perfect.

Suffolk County. Garnet and iron sands are often found along the coast of Long island. These sands are more abundant after storms, a fact of some interest as connected with the mode of their production. In the notice of magnetic iron sand (page 22), I have adverted to the theory which has been commonly received in regard to its occurrence, viz. that it pro-

* Gale. *New-York Geological Reports*, 1839.

ceeds from the disintegration of masses of iron ore, the grains being afterwards washed down by rains. But a serious objection to the adoption of this as a general theory is, that these sands often contain substances which are not usually found in these beds of iron ore; as, for example, garnet, and crystallized titaniferous iron ore.

Mr. Mather has suggested that this garnet sand might be advantageously used as a substitute for emery. It could be easily separated from the particles of iron ore by the magnet.

Warren County. Garnet will probably be hereafter found abundantly in this county. At present, however, only one locality is known to me, which is on Lake George, about eight miles from Ticonderoga, where it is associated with tourmaline.

Westchester County. Garnet, in trapezoidal crystals, often much rounded and usually of some tint of red, is found in the gneiss and granite at West-Farms and New-Rochelle, and in hornblende bowlders at Davenport's neck. On the Croton aqueduct, near the village of Yonkers, rounded crystals, apparently trapezoidal, are abundant in the black mica and gneiss. They are of a rose red and dark red colour, and are usually from a quarter to half an inch in diameter.

In the same vicinity, there has been found in the gneiss a beautiful massive variety, which is often transparent, and varies in colour from rose to blood-red with a tint of blue. It compares favorably with any of the foreign specimens of almandine and pyrope, and when cut and polished, forms a beautiful gem. The cross fractures, however, are so numerous that it is difficult to obtain large pieces which answer the purposes of the lapidary.

A single irregular crystalline mass of this mineral was found by Dr. Horton and myself, of about eighteen inches in diameter, and weighing fifty or sixty pounds. Near the surface of the mass, the mineral was less pure, and was arranged in plates or layers, with a little quartz and mica interposed between them.

In Massachusetts, geodes of garnet, of a cinnamon-brown colour, are found accompanied by scapolite in white limestone at Carlisle, and at Boxborough; and crystals of a dull red colour are found in the mica slate, in Chesterfield.

In Connecticut, trapezoidal crystals of a fine red colour are found at Haddam, where they are associated with chrysoberyl, automalite and columbite; while in Monroe, Washington and several of the neighbouring towns, reddish brown crystals are found in the mica slate.

In New-Jersey, at Franklin furnace, melanite in fine crystals is found in limestone.

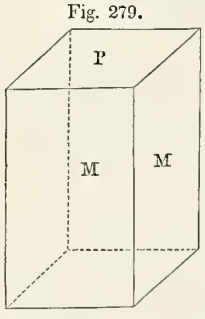
In New-Hampshire, the most perfect and beautiful crystals that have yet been found in the United States, occur at Franconia. Fine specimens are also obtained at Hanover in the same State.

SCAPOLITE.

[From the Greek σκαπος, a *rod*, and λιθος, a *stone*; in allusion to the rod-like appearance of the crystals.]

Paranthine, Wernerite, Meionite, and Dipyre. *Haüy.* — Scapolite, and Meionite. *Cleaveland.* — Meionite or Scapolite, and Gabronite. *Thomson.* — Scapolite, and Nuttalite. *Phillips.* — Pyramidal Feldspar or Scapolite, and Meionite. *Jameson.* — Pyramidaler Elain-Spath. *Mohs;* and Nuttalite. *Mohs* (App. II. 660). — Meionite, and Wernerite. *Beudant.* — Scapolite. *Shepard* and *Dana.*

Fig. 279.



Description. Colour, white, grey, green, yellow or red. It occurs regularly crystallized; also massive and disseminated. The primary form is a right square prism, Fig. 279; but it often occurs in prisms of eight or twelve sides, variously terminated and sometimes aggregated laterally. Cleavage parallel to the sides, terminal planes and both diagonals of the primary. Fracture conchoidal and uneven. Lustre shining, pearly, resino-vitreous and resino-pearly. From transparent to opaque. Brittle. Hardness from 5.0 to 5.5. Specific gravity from 2.50 to 2.75. By calcination, it gives off water without losing its transparency. Before the blowpipe, it fuses with intumescence into a colourless semi-transparent mass; with borax, with effervescence into a transparent glass. It is attacked with difficulty by the acids, the solution being precipitated by oxalate of ammonia.

Its crystalline form, specific gravity, and inability to become electric by heat and to form a jelly with acids, will serve to distinguish scapolite from some varieties of zeolite, stilbite, etc., which it often resembles.

The different varieties of minerals belonging to this species were found at different times; and not resembling each other in their external characters, they received different names. Thus, Haüy describes as distinct the Meionite, Wernerite and Paranthine, although his figures of the crystalline forms of the three minerals are almost exactly similar. Subsequent crystallographical examinations and chemical analyses have sufficiently established their identity; and they are now, with some other varieties, usually included under the name of Scapolite.

Meionite. This includes the white, more transparent and highly crystallized varieties.

Scapolite. It consists of the translucent and opaque crystals, and the massive varieties which are tinged green, black and red.

Wernerite. This name is usually applied to the crystallized variety, which has a greenish or greenish grey colour.

Nuttallite. This name was given by Brooke to a variety which has a grey or bluish colour, and is softer and has a more vitreous fracture than common scapolite. It also possesses a play of light on the faces of the prism, similar to that of elaolite. It is, however, identical in crystalline form and composition.

Paranthine includes the more compact varieties. It has a pure white or pale blue colour; while *Dipyre* is of a grey or reddish white colour, and becomes slightly phosphorescent on the application of heat.

Composition. *Meionite*—Silica 45.53, alumina 32.73, lime 24.25, potash and soda 1.82, protoxide of iron 0.18 (*Stromeyer*).

Scapolite—Silica 43.83, alumina 35.43, lime 18.96. water 0.03 (*Nordenskiold*).

Wernerite—Silica 50.25, alumina 30.00, lime 10.45, potash and soda 2.00, protoxide of iron 4.45, water 2.85 (*John*).

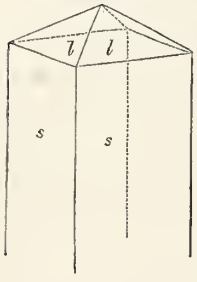
Nuttallite, from Bolton, Massachusetts—Silica 46.30, alumina 26.48, lime 18.62, soda with lithia 3.64, water 5.40 (*Thomson*).

Dipyre—Silica 60.00, alumina 24.00, lime 10.00, water 2.00 (*Vauquelin*).

The formula for scapolite is probably $3Al_2O_3Si + CaSiO_3$.

Geological Situation. In this State, it is almost exclusively confined to beds of white limestone, in which it is usually associated with sphene and pyroxene. The meionite is often found in a red calcareous spar. It has not been observed, as in Norway and elsewhere, in beds of magnetic ironstone and iron pyrites in gneiss.

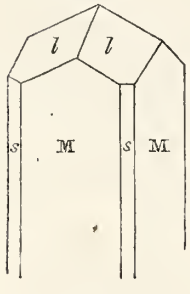
Fig. 280.



Essex County. Scapolite in imperfect crystals, and in masses having an almost fibrous structure, occurs abundantly associated with pyroxene, near Kirby's graphite mine, four miles northwest of the village of Alexandria in Ticonderoga. It is white, greyish or greenish white and green. The crystals are large, and the masses are cleavable, and sometimes appear to be made up of long and slender crystals of the primary form. This mineral also occurs in the town of Keene, in crystals in which the primary planes are extinguished by the extension of the planes *s*, Fig. 280. The secondary form, therefore, can be distinguished only by the inclination of the faces *l* :* *s* on *s* 90° ; *s* on *l* 122° 10′.

Lewis County. Near the Natural bridge, is a remarkable locality of the variety *Nuttallite*. It occurs crystallized. The crystals are often very perfect and variously modified, but most generally they are rounded on the edges as if by fusion. The colours are white, bluish and dark grey; and the mineral exhibits the high vitreous lustre and the play of light peculiar to this variety. The specific gravity is 2.712. It is associated with pyroxene, sphene and apatite in a highly cleavable variety of white calcareous spar. Among the crystalline forms which have been observed at this locality, are the primary (Fig. 279), and those represented in Fig. 281, in which the edges of the prism are replaced by narrow tangent planes, and the solid angles are also replaced by planes ;

Fig. 281.



* Emmons. *New-York Geological Reports*, 1837.

Fig. 282, the *dioctaèdre* of Haüy, in which the replacing tangent planes are broader;

Fig. 283, in which two of the replacing planes are much larger than the other two, giving the crystal a flattened form;

Fig. 284, in which the edge between l and l is replaced by the plane t;

Fig. 285, in which the edge between M and l is replaced by the plane z;

Fig. 282.

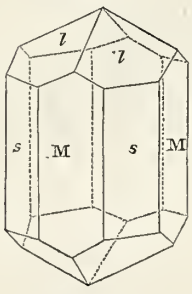


Fig. 283.

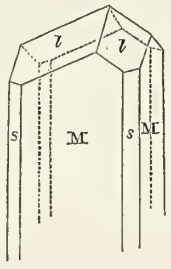


Fig. 284.

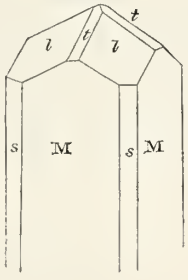
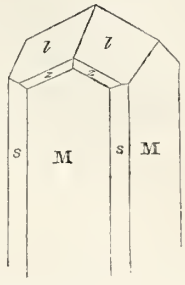


Fig. 285.



Also Figs. 286, 287, and a modification of the *triplante* of Haüy, Fig. 288.

Fig. 286.

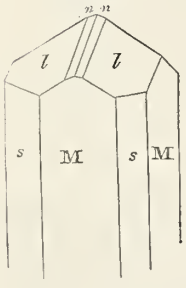


Fig. 287.

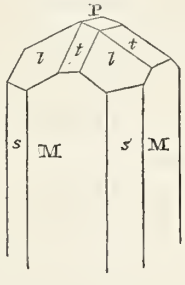
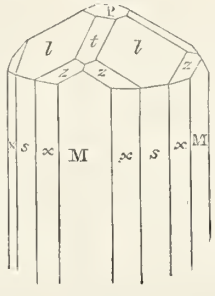


Fig. 288.



M on l 112° 30′
M on s 135° 00′
M on t 113° 34′
M on x 153° 26′
M on z 140° 11′
l on l 136° 22′
l on s 122° 10′
l on t 158° 11′
l on z 151° 38′
s on x 161° 34′
z on z 150° 18′ (*Haüy*).

Orange County. There are sevcral localities of scapolite in this county. Near West-Point, it is in large, white and compact masses, associated with pyroxene. At Fall hill in the town of Monroe, there is a very compact variety of a white and bluish white colour, and having a flat conchoidal fracture. It is associated with the beautiful lamellar pyroxcne, heretofore noticed.

At Two-ponds in thc same town, there is a remarkable locality of crystallized scapolite. The crystals are white and reddish white, opaque, and sometimes rough. They are often very large, and grouped. One of them is nearly ten inches in length, and five inches in diameter. It is associated with pyroxcne, sphene and zircon.

The same variety is also found at Greenwood furnace; while that which has been called *Meionite*, but which is seldom transparent, occurs in the form of minute crystals or grains in limestone at the Two ponds, the Forest of Dean and elsewhere. It is often associated with red calcareous spar.

Among the crystalline forms observed in this town, are those represented in Figs. 282 and 284, already introduced; together with those annexed, viz. Figs. 289, 290, 291, 292, 293, 294, and 295 :*

Fig. 289.

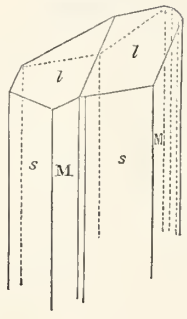


Fig. 290.

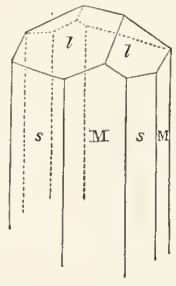


Fig. 291.

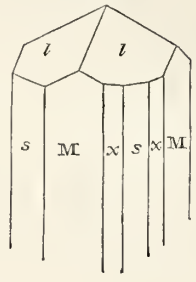


Fig. 292.

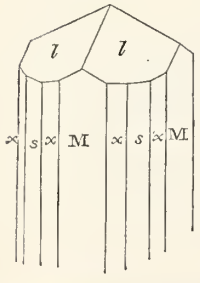


Fig. 293.

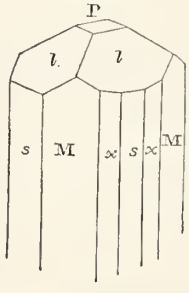


Fig. 294.

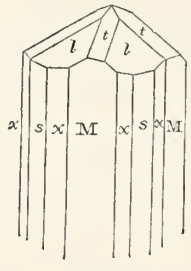
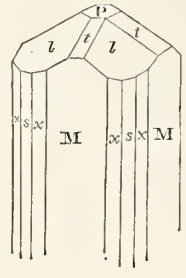


Fig. 295.



The measurements are the same as those given under Lewis county.

In the town of Warwick, scapolite occurs near the village of Amity, in milk white crystals, with the surfaces often dendritic. They are sometimes two or three inches in length, but are generally imperfect. The associates are pyroxene, sphene and graphite. There is another locality a mile and a half south of this village; another, five miles south of Warwick; and still another, about two miles north of the village of Edenville. The forms obtained in this town are the primary (Fig. 279); the same, with two edges of the prism replaced by tangent planes, Fig. 296; the same with two opposite edges replaced, Fig. 297; also Fig. 298, and Figs. 280 and 282.

Fig. 296.

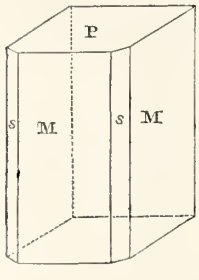


Fig. 297.

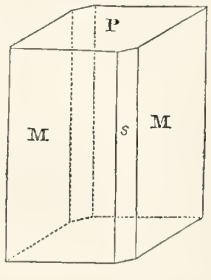
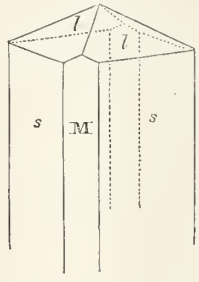


Fig. 298.

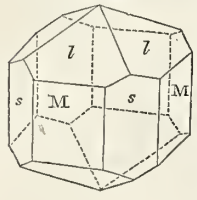


* For several of these modifications, I am indebted to Dr. Horton.

Putnam County. Small, white, somewhat rounded and opaque crystals of scapolite, associated with sphene, apatite, quartz, etc., are found in the white limestone at Hustis' farm and elsewhere in Phillipstown. The forms are the primary and the eight-sided prism, but they are seldom perfect.

St. Lawrence County. Scapolite, both crystallized and massive, occurs in the white limestone in the vicinity of the village of Gouverneur. It is associated with apatite, sphene and pyroxene. The crystals are white, translucent to semi-transparent, and possess a high degree of perfection and finish. The forms observed are the primary (Fig. 279); the *dioctaèdre* of Haüy, usually with the prism very short, as in Fig. 299; and a modification of Fig. 293, the prism having only ten, instead of twelve, lateral planes.

Fig. 299.

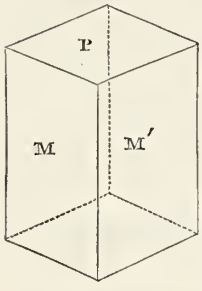


STAUROLITE.

[From the Greek σταυρος, *a cross*, and λιθος, *a stone*; on account of the cruciform appearance of its compound crystals.]

Staurotide. *Haüy, Cleaveland, Thomson, Beudant* and *Shepard.* — Staurolite. *Phillips.* — Prismatoidal Garnet, or Grenatite. *Jameson.* — Prismatoidischer Granat. *Mohs.* — (Called also Pierre de Croix.)

Fig. 300.



Description. Colour dark reddish brown, sometimes almost black. Streak white. It always occurs crystallized. Primary form a right rhombic prism, Fig. 300. M on M′ 129° 30′. The acute lateral edges are often replaced by planes, forming a six-sided crystal. Cleavage parallel to *o* (Fig. 301) perfect; traces in the direction of M. Fracture conchoidal, uneven. Lustre vitreous, inclining to resinous. Ranges from translucent to opaque. Hardness 7.0 to 7.5. Specific gravity from 3.20 to 3.90. Before the blowpipe it is infusible, or difficultly fusible in a black scoria; with borax, it melts slowly into a transparent deep green coloured glass.

The form and infusibility distinguish this mineral from garnet, with which it is usually associated.

Composition. Silica 48.00, alumina 40.00, lime 1.00, oxide of iron 9.50, oxide of manganese 0.50 (*Decotils*).

Geological Situation. In this State, staurolite is always found in gneiss or mica slate.

LOCALITIES.

Dutchess County. Staurolite is found associated with garnet, in mica slate, at the Foss iron ore bed in the town of Dover. The crystals are usually small, and are of the primary form (Fig. 300); the primary with the acute lateral edges replaced by tangent planes, *péri-*

hexaèdre of Haüy, Fig. 301 ; the same with the obtuse solid angles replaced by single planes, *unibinaire* of Haüy, Fig. 302, and Fig. 303. The twin crystal, Fig. 304, *geminée obliquangle*

Fig. 301.

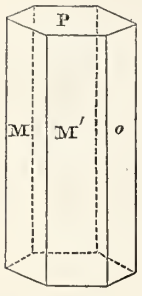


Fig. 302.

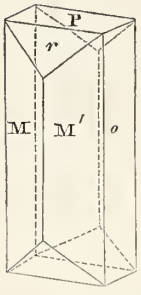


Fig. 303.

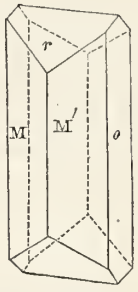
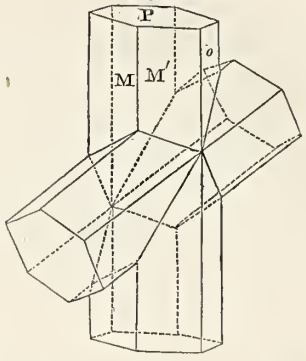


Fig. 304.



of Haüy, has also been observed at this locality, although it is usually imperfect. M on M′ 129° 30′ ; M or M′ on P 90° ; M on *o* 115° 18′ ; M or M′ on *r* 137° 58′.

New-York County. Three and a half miles from the city, on the banks of the Hudson, this mineral is found in mica slate. It has the form of short but very perfect rhombic prisms, with the acute lateral edges replaced by tangent planes, and terminated by dihedral summits (Fig. 303), and sometimes forming an imperfect cross.*

Staurolite probably occurs also in the counties of Rockland and Westchester. I have found it in bowlders of mica slate on the banks of the Hudson, at Nyack. These bowlders more nearly resembled the rocks found in Westchester, than those of Rockland.

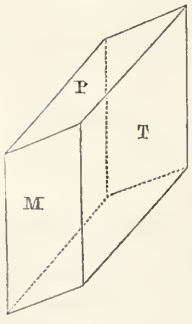
This mineral has been observed in the mica slate in Massachusetts and Connecticut.

FELDSPAR.

[From the German Feldspath, *fieldspar ;* probably from its being often found loose on the surface of the ground.]

Feldspar. *Thomson*, *Shepard* and *Dana.* — Prismatic Felspar, or Common Felspar. *Jameson.* — Orthotomer Feld-Spath. *Mohs.* — Orthose. *Beudant.* — Felspar. *Phillips.*

Fig. 305.



Description. Colour white, grey, green, blue, red and brown, sometimes with a pearly opalescence. Streak greyish white. It occurs regularly crystallized ; and also massive and disseminated. The primary form is a doubly oblique prism. Fig. 305. M on T 120° 35′ ; P on M 90° ; P on T 67° 15′. Cleavage parallel with P and M perfect ; with T obscure, though sometimes easily obtained. Fracture conchoidal, splintery, slaty and earthy. Lustre vitreous or vitreo-pearly. From transparent to opaque. Brittle. Hardness 6.0. Specific gravity from 2.39 to 2.58. Before the blowpipe, on char-

* Pierce and Torrey. *Cleaveland's Mineralogy.*

coal, it melts with difficulty into a blebby semi-transparent glass; with borax, it dissolves into a clear globule. It does not give out water by calcination, and is not acted on by acids.

Varieties. *Common Feldspar.* This is mostly opaque, or translucent only on the edges. It is of various colours, and is either crystallized or massive. It is very widely diffused, as it forms one of the constituents of granite.

Adularia, sometimes called *Moon-stone.* A semi-transparent or translucent variety, which is white, greyish or milk-white, and is frequently iridescent. It sometimes has a pearly lustre, and exhibits, when cut and polished, a bluish or greenish white chatoyant reflection, whence the name *moonstone* is derived.

Glassy Feldspar. This includes the semi-transparent varieties. It has a vitreous lustre, whence its name. It occurs generally in crystals which have the appearance of being cracked in various directions. This is considered as a distinct species by Dr. Thomson.

Ice Spar. Occurs in white, transparent or translucent flattish crystals.

Porcelain Clay, or *Kaolin.* This is a decomposed feldspar, which is massive and disseminated in certain rocks, and is composed of small particles which possess but slight coherence. It adheres to the tongue, and is soft and meagre to the touch. Crystals of feldspar, mica, etc. are sometimes found in it.

Necronite. This variety is characterized by giving out an offensive odour on being rubbed or struck, but it does not differ in other respects from common feldspar.

Composition. *Adularia*—Silica 64.24, alumina 18.40, potassa 16.95, lime trace (*Berthier*).

Lamellar Feldspar (red)—Silica 65.03, alumina 17.96, potassa 16.21, lime 0.35, peroxide of iron 0.47 (*Beudant*).

Green Feldspar—Silica 62.85, alumina 17.02, potassa 13.00, lime 4.00, oxide of iron 1.00 (*Vauquelin*).

Geological Situation. Feldspar is one of the most abundant minerals, and it occurs in most of the primary rocks. The finest specimens in this State are in or near the white limestone.

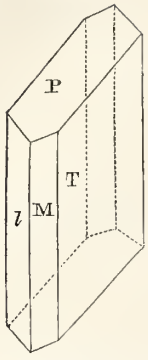
Uses. Some of the varieties of compact feldspar are susceptible of a fine polish, and are esteemed by the lapidary. They are also used in the manufacture of porcelain.

LOCALITIES.

Dutchess County. Ferruginous green feldspar, containing granular epidote, is said to occur in Rhinebeck.

Essex County. At Rogers' rock, adularia and common feldspar are found associated with various other minerals. Sometimes it is in minute transparent crystals in a loosely aggregated mass, associated with garnet and small crystals of calcareous spar. The crystals

Fig. 306.



resemble the *prismatique* of Haüy. Fig. 306. M on *l* 120° ; P on *l* 111° 40′.

The variety necronite, in translucent crystals, usually imperfect, is also found at this locality. It is very fetid when rubbed briskly, or when struck with a hammer.

About five miles north of Ticonderoga, in Crown-Point, good cleavages of red feldspar have been obtained. The associates are quartz and magnetic iron ore.

In Newcomb, it occurs, according to Dr. Emmons, of a green colour.

To these localities several others might be added, as there is scarcely a mine of magnetic iron ore at which feldspar is not found, either as an associate of the ore, or forming a part of the rock in the immediate vicinity. But I have never observed it in these situations exhibiting regular crystalline forms, although it is often susceptible of cleavage.

Herkimer County. Fine cleavages of feldspar of pale flesh-colour, may be obtained on the banks of the canal in the immediate vicinity of Little-Falls. Other common varieties also occur in the gneiss near this village.

Jefferson County. A valuable bed of whitish feldspar occurs on High island, in the St. Lawrence, nearly opposite to Alexandria. It is said to be suitable for the manufacture of porcelain.*

Fig. 307.

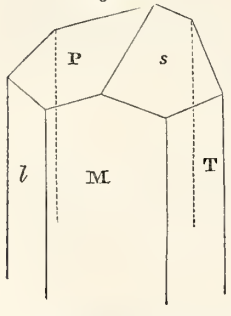
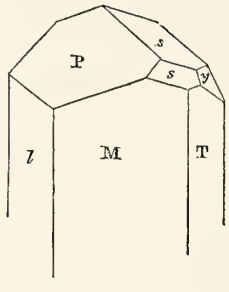


Fig. 308.



Lewis County. Near Natural bridge, feldspar, both crystallized and massive, is found in white limestone. The crystals have a white and yellowish white colour, and are from a quarter to three-quarters of an inch in length. They are associated with pyroxene and hornblende. Among the forms are the *prismatique* of Haüy (Fig. 306); and also the modifications represented in Figs. 307 and 308. M on *l* 120° ; P on *l* 111° 40′; P on *s* 124° 10′; P on *y* 99° 29′ (*Haüy*).

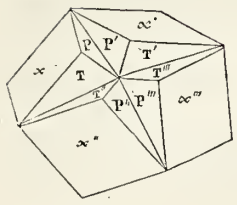
The massive variety often has a bluish colour, and is associated with the black pyroxene, scapolite and sphene, for which this locality is so much celebrated.

New-York County. At Thomson's quarry, near 196th-street (Kingsbridge), necronite or fetid feldspar is found in the white limestone. It is bluish white, and is very fetid when struck.

At Harlem (30th-street and 9th avenue), small crystals of feldspar, of the primary form, are found in the fissures of gneiss. There is also a six-sided prism formed by the truncation

* Emmons. *New-York Geological Reports*, 1837.

Fig. 309.



of the acute lateral edges, the *prismatique* of Haüy (Fig. 306), but differing in the relative size of the planes. The singular twin crystal, Fig. 309, has been found here by Dr. Horton.

Crystals of feldspar and adularia, usually small, are found in other parts of the island, both in the quartz which traverses the limestone, and in the fissures of gneiss. Cleavable masses, often of considerable size, and sometimes having a reddish colour, also occur in similar situations.

Orange County. Common feldspar is of course very abundant in this county. Fine specimens having the primary form, and often of a flesh-red colour, occur in the vicinity of West-Point. A beautiful white and opalescent variety occurs at Bog-meadow pond, in the town of Cornwall.

At the Long, Roberts, Patterson, Stirling and Rich iron mines, massive feldspar is common; at the two latter, it is red.

In the town of Warwick, it is found at Rocky hill, of a white colour. At McGee's hill, it is red.

Fig. 310.

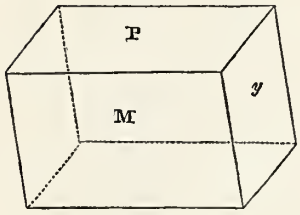
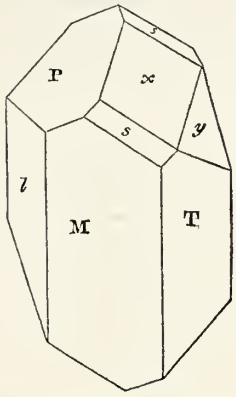


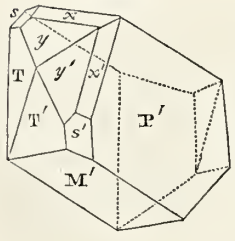
Fig. 311.



Of crystallized feldspar, Rocky hill in the town of Warwick is one of the most interesting localities. The colours are white, yellowish and reddish white. It is associated with tourmaline and zircon. There have been found here, the *prismatique* of Haüy (Fig. 306); also the *unitaire* of Haüy, Fig. 310; and the *sexdécimal* of Haüy, Fig. 311.

P on x 128° 51′;
P on y 99° 29′;
M on x 90°.

Fig. 312.



Near Amity, there is found crystallized feldspar, which is white and yellowish white. The *prismatique* of Haüy is met with, and sometimes twin crystals occur of the form represented in Fig. 312.

There is also a locality of this variety about a mile northwest of Edenville, where it is associated with green tourmaline.

Putnam County. On Hustis' farm, in the town of Phillipstown, feldspar is found in laminæ of considerable size, associated with pyroxene, etc. It is of a reddish colour.

Richmond County. Feldspar, in thin plates, and in minute crystals having the primary form, occurs in the fissure of greenstone near Port Richmond, formerly Merserole's ferry. This locality is the so called *Granite quarry*.

Rockland County. Minute crystals of feldspar are found imbedded in the variegated limestone at Montaigne's quarry, two and a half miles northwest of Grassy point. This is also one of the minerals imbedded in the greenstone near Piermont.

St. Lawrence County. The most interesting localities of feldspar hitherto found in the State of New-York, occur in this county.

A mile southwest of the village of Gouverneur, large crystals of feldspar have been obtained. They are white, and are highly modified. The associates are quartz, green pyroxene, and babingtonite.

Eight miles from Potsdam on the road to Pierrepont, feldspar is said to have been found in crystals twelve inches in diameter.* And according to the same gentleman, quoted below, there is a hill of red feldspar about a mile beyond Allen's mill, on the Oswegatchie.

There is a fine locality of crystallized feldspar in the town of Rossie, two miles north of the village of Oxbow, where it is associated with pargasite, pyroxene, sphene and apatite. The crystals are white and bluish-white, and vary in size from a quarter of an inch to an inch in diameter.

Among the forms obtained here, are those represented in Figs. 307, 308 and 310; and also in Fig. 313, the *quadrihexagonal* of Haüy, with the faces M and P enlarged; Fig. 314; and Fig. 315, a modification of the *déciduodécimal* of Haüy. M on n 135°; M on s 116° 20′; M on y 90°; M or T on z 150°; P on y 99° 29′; P on s 124° 10′.

Fig. 313.

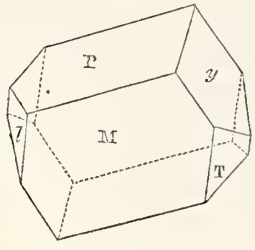


Fig. 314.

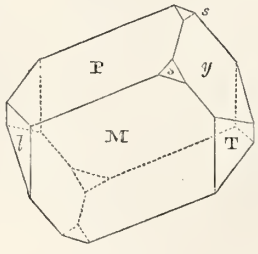
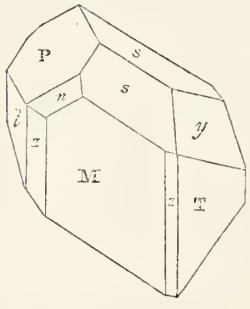


Fig. 315.



Near De Long's Mill, in the town of Hammond, crystallized feldspar is found associated with apatite and zircon, in white limestone. The crystals are yellowish white or dark brown, and they are often bent, and have the edges rounded as if they had been fused. There have been found at this locality the *sexdécimal* (Fig. 311), and the *synoptique* of Haüy, Fig. 316; also Fig. 317, and the twin crystals represented in Figs. 318 and 319, in which the face of composition is parallel, and the axis of revolution perpendicular to M. M on n 135°; q on x 164° 40′.

* Finch. *American Journal of Science.* XIX. 220.

Fig. 316.

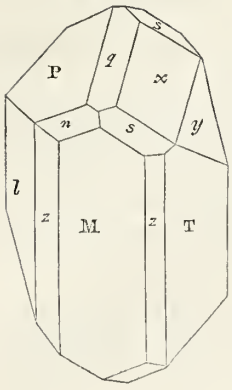


Fig. 317.

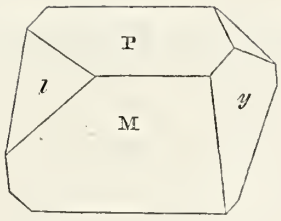


Fig. 318.

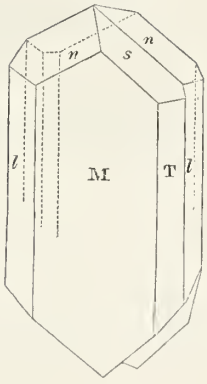


Fig. 319.

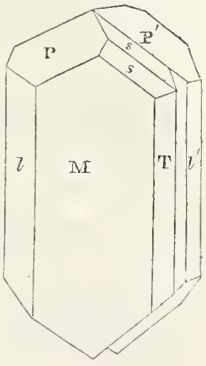
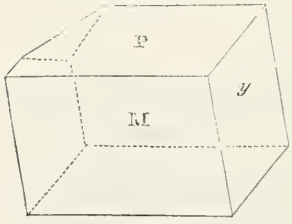


Fig. 320.



Saratoga County. Crystallized feldspar or adularia, associated with chrysoberyl, tourmaline, garnet, etc., is found in a vein of coarse granite passing through gneiss, in the town of Greenfield, about a mile north of Saratoga-Springs. It is white, translucent, and often has a coating of silvery mica. The forms observed at this locality are those represented in Fig. 307, and Figs. 320, 321, 322, and 323. P on x 128° 51′.

Fig. 321.

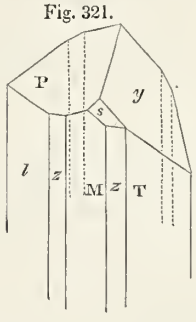


Fig. 322.

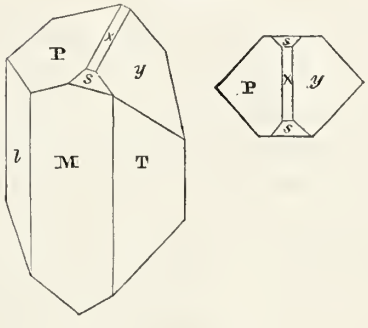
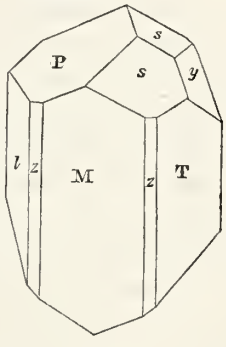


Fig. 323.



Suffolk County. At Cow bay, feldspar of an apple-green colour has been obtained in considerable quantities.*

Warren County. Feldspar, affording large cleavages, of a white colour, is found in considerable abundance on the mountain about two miles west of the village of Caldwell.

On French mountain, three miles south of the same village, there is a vein of feldspar or adularia, containing small quantities of magnetic iron ore, which has been somewhat worked.

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* Pierce and Torrey. *Cleaveland's Mineralogy.*

The feldspar is white and red, and often affords large cleavages. It is sometimes beautifully variegated with narrow veins and small masses of quartz.

It is scarcely necessary to add, that common feldspar is found in various other parts of this county.

Washington County. Feldspar is found in the town of Putnam, about a mile south of Black point on Lake George, where it is associated with pyroxene and mica.

Westchester County. Feldspar and hornblende occur at Peekskill; and at Tarrytown there is a greenish grey variety, in extensive beds from three to nine feet thick, connected with mica slate.

The same mineral, often giving large and good cleavages, is often found in the vicinity of West-Farms, New-Rochelle, and along the line of the Croton aqueduct near Yonkers and elsewhere. It is sometimes of a reddish tint, but I am not aware that perfect crystals have been obtained.

APPENDIX.

Porcelain clay, or *Porcelain earth*. The localities of this valuable material hitherto observed in this State, are enumerated in the first part of this work (page 59). It is chiefly found in the counties of Essex and Warren, where it is thought to be abundant. This is supposed to be similar to the *kaolin* of the Chinese, from which the finest specimens of porcelain are manufactured. Should it be found in sufficient abundance, it must become one of the most important of our mineral products.

It has already been stated that the occurrence of this clay is generally ascribed to chemical changes effected in various kinds of felspathic rocks, although the precise nature of these changes does not seem yet to be understood.

This clay is principally composed of silica and alumina, and is considered a silicate of alumina, although small quantities of potassa and magnesia are also occasionally found with these ingredients.

It appears that the talcose granite, or the variety called *protogine*, is that which most frequently furnishes beds of porcelain clay; and Mr. Boase has suggested that the presence of magnesia in the feldspar of this rock may, among other causes, contribute towards the extraordinary change which this rock experiences. "Thus, the magnesia" which it contains "may absorb carbonic acid, as well as the alkali from the percolating water; and so great is its tendency to combine with two proportions of this acid, that even one part of the carbonate will attract the acid of the other, so as to pass into the bicarbonate of magnesia; in which state being soluble in water, it would be speedily removed." This he thinks would in some measure explain the origin of kaolin, and also account for the small quantity of the earth remaining in the porcelain clay. Indeed, he states that in some samples which he has examined, not a trace of magnesia could be detected.*

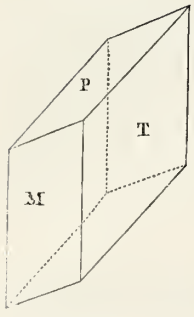
* H. S. Boase. *London and Edinburgh Philosophical Magazine and Journal of Science.* 3d series. X. 348.

LABRADORITE.

[From its having been first found on the coast of *Labrador*.]

Opalescent Feldspar, var. of Feldspar. *Cleaveland.* — Labradorite. *Thomson, Phillips* and *Shepard.* — Polychromatic or Labrador Feldspar. *Jameson.* — Polychromatischer Feld-spath. *Mohs.* — Labradorite, App. to Chabasie. *Beudant.*

Fig. 324.



Description. Colour grey, with splendent opaline reflections of brilliant blue, green, yellow, red and pear grey hues. It sometimes occurs crystallized, but is usually massive and disseminated. Primary form a doubly oblique prism. Fig. 324. M on P 94° 30′; M on T 115°; P on T 119°. Cleavage parallel to the base most perfect. Lustre pearly on the perfect cleavage faces. Translucent when in thin fragments. Brittle. Hardness 6.0. Specific gravity from 2.69 to 2.76. Before the blowpipe, it behaves like feldspar. When in powder, it is soluble by digestion in muriatic acid.

Composition. *A specimen from Labrador* — Silica 55.75, alumina 26.50, lime 11.00, soda 4.00, oxide of iron 1.26, water 0.50 (*Klaproth*).

Geological Situation. This mineral was first observed on the coast of Labrador, as a constituent of syenite. It has since been found in Greenland, and in various parts of Europe.

LOCALITIES.

Essex County. Labradorite is very abundant in this county. Its colour is smoke-grey of various shades, generally opaque, but often translucent, when the laminæ are not more than an eighth of an inch in thickness. In the most perfect specimens there are two reflections of colour, a blue and a green appearing in two directions from the cleavage faces. The bronze or copper-coloured reflections appear in pieces which are weathered. The polished pieces form gems which are esteemed in jewelry.*

Fine specimens of labradorite are found in the form of bowlders of various sizes, in the towns of Moriah, Westport and Lewis.

As this is a matter of interest in connexion with the subject of drift, it may be stated, that bowlders of labradorite have been noticed in the counties of Lewis, St. Lawrence, Warren, Schoharie, Greene and Orange. In the latter they occur in several of the towns, and weigh from a few pounds to several tons. Some of the specimens have been polished, and are very fine. They usually reflect only the green and blue colours.

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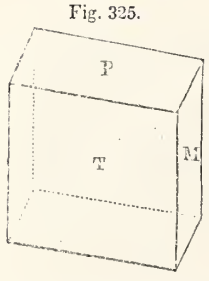
* Emmons. *New-York Geological Reports*, 1838.

ALBITE.

[From the Latin *albus, white;* because the specimens found were of a white colour.]

Albite. *Phillips, Thomson* and *Beudant.* — Tetarto-Prismatic Feldspar, or Albite. *Jameson.* — Tetartoprismatischer Feld-Spath. *Mohs.* — Variety of Feldspar. *Cleaveland.* — Cleavelandite. *Brooke* and *Levy.*

Fig. 325.



Description. Colour usually white; sometimes grey, green or brown. Streak white. It occurs regularly crystallized, frequently in twins; also massive and disseminated. Primary form a doubly oblique prism. Fig. 325. M on P 93° 30′; M on T 117° 53′; P on T 115° 5′. Cleavage perfect parallel to M and P, less so to T. Fracture imperfectly conchoidal. Lustre pearly upon cleavage plane, vitreous in other directions. Transparent to translucent on the edges. Hardness 6.0. Specific gravity 2.60 to 2.68. Its behaviour before the blowpipe is similar to that of feldspar.

Composition. *Specimen from Chesterfield, Mass.* — Silica 70.68, alumina 19.80, soda 9.06, lime 0.23, oxide of iron and manganese 0.11 (*Stromeyer*).

Geological Situation. Albite often forms a constituent of greenstone and granite, and is sometimes associated with common feldspar.

LOCALITIES.

According to Dr. Emmons, much of the granite at Gouverneur, in St. Lawrence county, contains albite.* Beautiful white and transparent crystals, often twins, have been found in Granville, Washington county. The specimens, for which I am indebted to Dr. Emmons, exactly resemble those obtained in the vicinity of Castleton, Vermont.

In Massachusetts, albite is found in crystals, at Williamstown, Chesterfield and Goshen. The crystals are often of considerable size, and twins are not uncommon.

STELLITE.

[From the Greek στελλα, *a star;* on account of the star-like arrangement of its crystals.]

Stellite. *Thomson, Dana* and *Mohs* (App).

Description. Colour snow-white. It consists of a congeries of small crystals issuing like rays from several centres. The primary form seems to be an oblique four-sided prism, but the angles cannot be measured. It is tough, and has some resemblance to asbestus and the nemalite of Mr. Nuttall. Lustre silky, shining. Translucent. Hardness 3.25. Specific

* *New-York Geological Reports,* 1838.

gravity 2.612. Before the blowpipe, it fuses into a beautiful white enamel. With carbonate of soda, it fuses with effervescence into a transparent white bead. With borax, it fuses into a perfectly transparent glass when the quantity of stellite is small; if it be larger, the bead exhibits a silica skeleton. It forms a jelly with muriatic acid.

From Thomsonite, which it often closely resembles, Stellite may be distinguished by the blowpipe characters. Its composition differs very much from that of many of the zeolite family.

Composition. Silica 48.46, lime 30.96, magnesia 5.58, alumina 5.30, protoxide of iron 3.53, water 6.10 (*Thomson*). The formula $Ca3SiO_3$ will probably express the composition of this mineral.

Geological Situation. This mineral has herctofore been observed only in rifts in greenstone.

LOCALITIES.

Rockland County. A mineral agreeing very well in its characters with the stellite of Thomson, is found in the rifts of greenstone at Piermont. The fibres are sometimes radiated; at others they are straight, when the mineral resembles the nemalite of Nuttall, but the blowpipe characters will at once distinguish it.

This mineral is believed also to occur in the greenstone bowlders in New-York and Westchester, where it has probably been mistaken for *Zeolite*, a name now rather applicable to a family of minerals than to a particular species.

The finest specimens, however, have been found at Bergen hill in New-Jersey. They are in the form of groups or congeries of needle-form crystals, which are exceedingly sharp. These needles are tough, and when subjected to the pestle, appear like amianthus. The specific gravity of one of the purest specimens is 2.836. Before the blowpipe, it fuses readily, with some effervescence, into a white enamel. The composition of a specimen from this locality is as follows, viz:

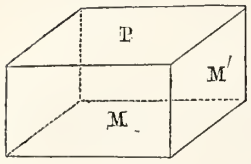
Silica,	54.60
Lime,	33.65
Magnesia,	6.80
Oxide of iron, with a little alumina,	0.50
Water and carbonic acid,	3.20

In chemical composition, our mineral differs from the stellite of Dr. Thomson, in its containing less alumina, oxide of iron and water. But these may after all be accidental ingredients. It closely resembles wollastonite, except that the latter has soda as one of its constituents. It differs from natrolite, in the small quantity of alumina which it contains.

MESOTYPE.

Zeolite. *Cleaveland.* — Prismatic Zeolite, or Mesotype. *Jameson.* — Prismatischer Kuphon-Spath. *Mohs.* — Mésotype. *Haüy, Beudant, Shepard* and *Dana.* — Mesolite. *Thomson.*

Fig. 326.



Description. Colour white, red, yellow and yellowish brown. It occurs crystallized, also pulverulent and fibrous. Primary form a right rhombic prism. Fig. 326. M on M′ 91° 10′ (*Brooke*), 91° 40′ (*Beudant*). Cleavage parallel with M, perfect. Fracture uneven, in some varieties coarse earthy. Lustre vitreous. Varies from nearly transparent to opaque. Brittle. Hardness from 5.0 to 5.5. Specific gravity from 2.14 to 2.23. Before the blowpipe, it froths, gives a phosphorescent light, and melts into a white semi-transparent enamel; with borax it fuses with difficulty into a transparent colourless glass. It is soluble in, and forms a thick jelly with, acids. It becomes electric by heat.

Its power of forming a jelly with acids, and of becoming electric by heat, will distinguish mesotype from several minerals which it resembles. Prehnite is harder, and does not form a jelly with acids.

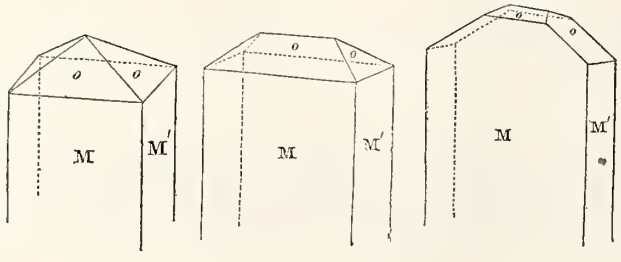
Varieties. The name *Natrolite* is applied to the yellow and brown varieties, in which the fibrous and granular concretions are intersected by laminæ. The *fibrous* variety consists of minute crystals aggregated in a radiating or stellular form. When it is very soft, and has an earthy fracture, it is sometimes called *Pearly zeolite.*

Composition. There is some diversity in the analyses of this mineral. According to Smithson, a specimen from the Faroe islands contained silica 49.00, alumina 27.00, soda 17.00, water 9.60.

Geological Situation. It occurs in cavities and veins in greenstone and trap, and also in the gneiss bordering on these rocks.

LOCALITIES.

Fig. 327. Fig. 328. Fig. 329.



New-York County. Minute but well defined crystals of mesotype are found in veins in gneiss at Harlem, where it is associated with apophyllite and stilbite. Figs. 327, 328 and 329 represent the forms which have thus been observed. M on *o* 116° 32′; *o* on *o* 144° 16′.

This mineral is said also, by Dr. Gale, to occur in the greenstone bowlders on the island.

The primitive rocks near New-York, and West-Farms in Westchester county, have been given as localities of zeolite, but I have no means of ascertaining whether the specimens belong to this or to some other species which were formerly confounded under that name.

It may be added, that fine specimens of mesotype occur, with various others of the zeolite family, at Bergen hill, New-Jersey.

STILBITE.

[From the Greek στιλβω, *to shine*, on account of its great lustre.]

Stilbite. *Haüy, Cleaveland, Phillips, Beudant* and *Shepard.* — Prismatoidal Zeolite, or Stilbite. *Jameson.* — Prismatoidischer Kuphon-Spath. *Mohs.*

Description. Colour white, sometimes grey, yellow or red. It occurs regularly crystallized; also in scopiform, stellular and foliated masses. Primary form a right rectangular prism,

Fig. 330.

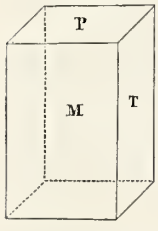


Fig. 330. Cleavage parallel to M and T, the former only perfect. Lustre vitreous; the lateral faces of the prism pearly. Alternates from semi-transparent to translucent. Hardness from 3.5 to 4.0. Specific gravity from 2.00 to 2.20. Becomes opaque by heat. Before the blowpipe, it exfoliates, and melts into a vesicular bead. Dissolves in acids; with difficulty forms a jelly in the cold. Its solution is precipitated by oxalate of ammonia.

Composition. Silica 52.50, alumina 17.07, lime 11.52, water 18.45 (*Thomson*).

Geological Situation. Although usually found elsewhere in trap rocks, in the State of New-York it occurs in veins and cavities in gneiss, white limestone and slate.

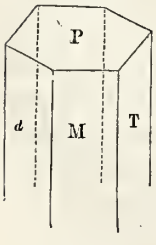
LOCALITIES.

New-York County. Small scopiform fibres or plates of a reddish or yellow colour occur in thin veins coating gneiss and granite, at the Harlem tunnel. It is sometimes associated with mesotype and epidote.

Orange County. Stilbite is said to have been found at West-Point, in this county.*

Putnam County. Two or three localities of this mineral occur in Phillipstown. Crystals

Fig. 331.



of the primary form (Fig. 330), and the modification represented in Fig. 331, have been found near Coldspring. M on *d* 133° 30′. The crystals are often grouped resembling a fan, and have a wax-yellow colour.

Opposite West-Point, where a locality of this mineral was discovered by G. Kemble, Esq., it occurs in a decomposing cellular bluish feldspar, forming a vein in gneiss. The crystals are of a honey-yellow colour, of the primary form, with several smaller and gradually diminishing cuneiform crystals applied to two opposite sides; giving them a radiated ap-

* Torrey. *American Journal of Science.* IX. 402.

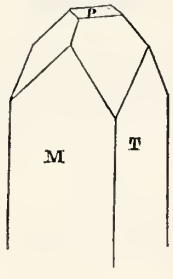
pearance, with deep reëntering angles on the sides. The summits are truncated at the terminal edges, and slightly bevelled in the direction of the laminæ of the crystal, which is also the case with the cuneiform additions.*

Fig. 332.

Rockland County. It is found in minute crystals in veins, with other zeolitic minerals, in the greenstone at Piermont. Fig. 332 represents a form observed here and at Bergen hill, New-Jersey. The specimens from the latter locality far exceed in beauty those heretofore found at Piermont. The crystals are nearly transparent, and although small, present very highly finished and brilliant faces. At Bergen hill, this mineral is also found in grouped or fasciculated crystals of a straw-yellow colour.

Westchester County. Near West-Farms, stilbite occurs in crystals lining the walls of seams in gneiss, with chabasite, heulandite and epidote. The colour varies from pale to deep red. It is also found near Bronx creek, in white six-sided tables, in an aggregate of epidote, hornblende, quartz and carbonate of lime, and in gneiss near Yonkers.

Fig. 333.



This mineral has recently been obtained in scopiform crystals of a dull yellow colour, sometimes with perfect terminations, near Peekskill. The vein is apparently from one half to three quarters of an inch wide, and is in a decomposing slate. The form represented in Fig. 333, has been found at this locality.

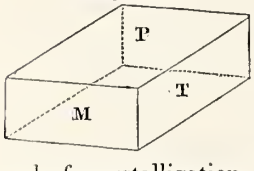
In Connecticut, stilbite is met with in seams in gneiss at Hadlyme, associated with heulandite, chabasite, etc. It is also found at Saybrook in the same State, and at Bellows-Falls in Vermont.

HEULANDITE.

[In honour of Mr. Heuland, of London.]

Stilbite. *Haüy* and *Cleaveland.* — Foliated Zeolite. *Werner.* — Hemi-prismatic Zeolite, or Heulandite. *Jameson.* — Hemiprismatischer Kuphon-Spath. *Mohs.* — Heulandite. *Beudant, Phillips, Shepard* and *Dana.*

Fig. 334.



Description. Colour white, grey, red and brown. It occurs regularly crystallized; also massive, and often globular. Primary form a right oblique angled prism. Fig. 334. M on T 130°. Cleavage parallel with P, highly perfect. Fracture conchoidal. Lustre vitreous, except P, which is in a high degree pearly, both as faces of cleavage and of crystallization. From transparent to translucent on the edges. Hardness from 3.5 to 4.0. Specific gravity from 2.20 to 2.50. Before the blowpipe, it melts with intumescence, emitting at the same time a phosphorescent light. It does not gelatinize with acids.

* Torrey. *American Journal of Science.* V. 399.

This mineral can in general be distinguished from stilbite by the difference in its crystalline form, but especially by the high pearly lustre of the terminal plane.

Composition. Silica 59.95, alumina 16.87, potash 7.19, water 15.40 (*Walmstedt*).

Geological Situation. Similar to that of stilbite, with which it is usually associated.

Westchester County. This mineral is said to have been found near West-Farms, associated with stilbite and epidote; but I have not been so fortunate as to meet with well characterized specimens. I cannot doubt, however, that it will be found in the trap and gneiss ranges in the southern part of the State, as most of the other minerals of this family are already known to occur in them. Small but very brilliant and perfect crystals of the primary form (Fig. 334), and of those modified as in Fig. 335 and 336, occur in cavities in the trap at Bound brook, New-Jersey. They are here introduced for the sake of future comparison. The same mineral is found at Paterson, New-Jersey. M on *a* 146° 30′; T on *a* 148°; P on *a* 111° 56′; M on *f* 114° 20′.

Fig. 335.

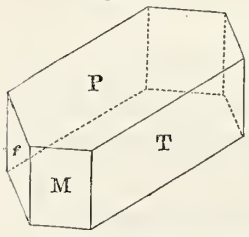
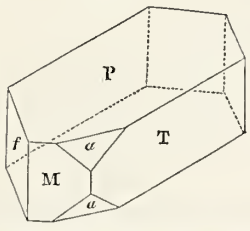


Fig. 336.



In Massachusetts, heulandite has been found at Chester; and in Connecticut, at Hadlyme.

EPISTILBITE.

Epistilbite. *Phillips, Beudant, Shepard,* and *Dana.* — Diplogener, Kuphon-Spath. *Mohs.*

Description. Colour white or yellowish. It occurs regularly crystallized. Sometimes also massive. Primary form a right rhombic prism. Fig. 337. M on M′ 135° 10′. Often in twin crystals. Cleavage highly perfect parallel with the shorter diagonal of the prism. Fracture in other directions uneven. Fig. 338 is one of the secondary forms. M or M′ on *t* 122° 9′; *t* on *s* 141° 47′; *t* on *t* 109° 46′; *t* on *u* 154° 51′. Lustre vitreous, except on the faces of cleavage and the corresponding crystalline planes, which are pearly. Transparent to translucent on the edges. Hardness from 4.0 to 4.5. Specific gravity from 2.20 to 2.25. Before the blowpipe, it melts, becomes white, intumesces, and forms a blebby enamel; with soda, it fuses into a transparent glass. It forms a jelly with acids, and the solution is precipitated by oxalate of ammonia.

Fig. 337.

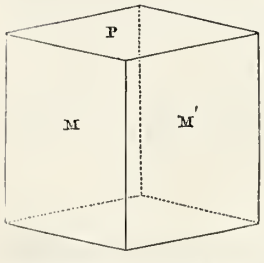
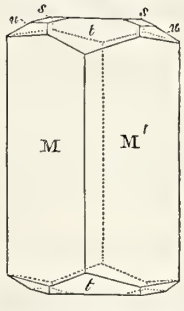


Fig. 338.



Composition. Silica 58.59, alumina 17.52, lime 7.56, soda 1.78, water 14.00 (*Rose*).

Geological Situation. It occurs in cavities and veins in trap and greenstone, along with others of the zeolite family.

LOCALITIES.

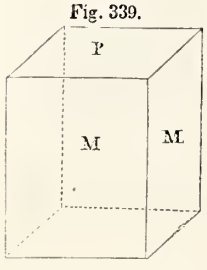
Epistilbite is said to occur in the greenstone at Bergen hill,* along with the other zeolitic minerals found at that locality. If such is the fact, I cannot doubt that it will also be met with in the greenstone and trap of Rockland.

APOPHYLLITE.

[Probably from its exfoliating before the blowpipe (*Phillips*).]

Apophyllite. *Haüy, Cleaveland, Phillips, Beudant, Thomson* and *Shepard.* — Pyramidal Zeolite, or Apophyllite. *Jameson.* — Pyramidaler Kuphon-Spath. *Mohs.*

Fig. 339.



Description. Colour white or greyish. It occurs regularly crystallized; also in straight and curved lamellar distinct concretions, massive and disseminated. The primary form is a right square prism, Fig. 339. Cleavage parallel with the primary faces, most perfect in the direction of P. Fracture uneven. Lustre internally glistening and vitreous; lateral planes of the prism shining: the terminal ones pearly. Ranges from transparent to translucent. Hardness from 4.5 to 5.0. Specific gravity from 2.20 to 2.50. Before the blowpipe it exfoliates, intumesces, and ultimately fuses into a white blebby glass; with borax, it melts readily into a transparent globule. In nitric acid, it separates into flakes; and when reduced to powder, becomes gelatinous and translucent.

Its crystalline form, the peculiar lustre of its terminal planes, and the action of acids, will form sufficient grounds of distinction between apophyllite and the minerals which it resembles.

Composition. *Specimen from Greenland*—Silica 51.86, lime 25.22, potash 5.31, water 16.90, fluoric acid trace (*Stromeyer*).

Geological Situation. Apophyllite occurs in fissures in trap and greenstone, and sparingly in the gneiss found near the pyrogenous rocks.

LOCALITIES.

New-York County. This mineral is occasionally found in veins and cavities in greenstone bowlders. It is also met with in the veins of gneiss at Harlem.

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* Bourne. *American Journal of Science.*

Fig. 340.

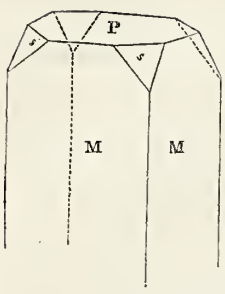


Fig. 341.

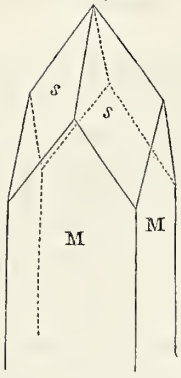
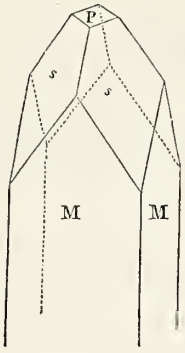


Fig. 342.



Rockland County. At Piermont, apophyllite occurs in the greenstone, but it has not hitherto been obtained in well defined crystals. Figs. 340, 341 and 342 represent the forms which have been observed in the same formation at Bergen hill, New-Jersey. M on M 90° ; P on M 90° ; P on *s* 120° 5′ ; M on *s* 128° 20′ ; *s* on *s* 104° 18′.

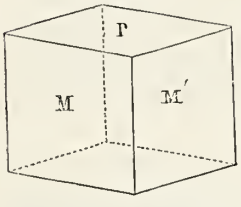
PREHNITE.

(In honour of its discoverer, Col. Prehn.)

Prehnite. *Haüy, Cleaveland, Phillips, Thomson, Shepard* and *Beudant.* — Axotomous Prehnite. *Jameson.* — Axotomer Triphan-Spath. *Mohs.*

Description. Colour commonly green of various shades, but sometimes grey and white. It occurs regularly crystallized ; also in scopiform, stellular and fibrous concretions, and massive. The primary form is a right rhombic prism. Fig. 343. M on M′ 100° (*Phillips*), 102° 30′ (*Beudant*). Cleavage distinct parallel to P ; less so, parallel to M. Fracture uneven. Lustre vitreous, except on the face P, which is pearly. Ranges from transparent to translucent. Hardness from 6.0 to 7.0. Specific gravity from 2.90 to 2.95. When heated, it becomes electric. By calcination, it yields water. Before the blowpipe, it melts into a white, greenish or pale yellowish frothy glass ; with borax, it forms a transparent bead. Slowly soluble in muriatic acid, from which solution an abundant precipitate is produced by oxalate of ammonia.

Fig. 343.



Prehnite has a lower degree of lustre than stilbite or heulandite, which it sometimes resembles. It does not, like many of the zeolite family, form a jelly with acids. By calcination, it yields less water than chabazite or epistilbite.

Composition. Silica 43.60, alumina 23.00, lime 22.33, oxide of iron 2.00, water 6.40 (*Thomson*).

Geological Situation. This mineral usually occurs in primitive rocks, or in trap and greenstone. It is found in both these situations in this State.

LOCALITIES.

Essex County. Prehnite occurs massive and semi-crystallized, and of a yellowish white

colour, on a quartzose rock near Westport. This is the mineral which was called *Chiltonite* by Dr. Emmons.

Richmond County. This mineral occurs in rolled masses of greenstone. It is also found in the form of thin plates, on the same rock, at Piermont in the county of Rockland.

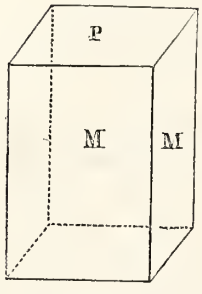
In Connecticut, prehnite occurs both massive and crystallized, in the trap at Farmington. In Massachusetts, it is found near Boston; in Vermont, at Bellows Falls; and in New-Jersey, at Paterson, Bound brook and elsewhere.

THOMSONITE.

[In honour of Dr. Thomas Thomson, of Glasgow.]

Thomsonite. *Phillips*, *Beudant*, *Shepard* and *Dana*. — Orthotomer Kuphon-Spath. *Mohs*. — Mesotype of *Haüy* in part.

Fig. 344.



Description. Colour, when pure, snow-white; also brown and yellowish. It occurs regularly crystallized; also in the form of spheres, and in masses having a fibrous radiated structure. Primary form a right square prism, Fig. 344. Cleavage perfect, parallel with M. Fracture uneven. Lustre vitreous, inclining to pearly. From transparent to translucent. Hardness 5.0. Specific gravity from 2.29 to 2.37. Before the blowpipe, it swells up like borax, and becomes opaque and snow-white, but does not melt. When exposed to a red heat, it becomes opaque, very white and shining like enamel. The edges are rounded, but it does not altogether lose its shape.

This mineral was formerly confounded with several others, under the general name of *Zeolite*. Haüy divided the zeolites into two species, which he distinguished by the names *Mesotype* and *Stilbite*. In 1817, Fuchs and Gehlen made an accurate chemical analysis of a number of zeolites, and showed that the mesotype of Haüy contains three distinct species, which they distinguished by the names of *Natrolite*, *Mesolite* and *Scolezite*. In 1820, Mr. Brooke, without being aware of what had been done by Fuchs and Gehlen, showed that the mesotype of Haüy ought to be divided into three species, which he distinguished by the names of *Mesotype*, *Needlestone* and *Thomsonite*. The first two of these constitute the natrolite and scolezite of Fuchs and Gehlen; but the third is a new species, which Mr. Brooke first described. He showed that these minerals differ in their crystalline shape, and in their specific gravity; thomsonite being the heaviest, and natrolite or mesotype the lightest.*

The stellite and wollastonite, with which this mineral has heretofore been often confounded, may be distinguished by their fusibility by the blowpipe.

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* See a paper on the Minerals found in the Neighborhood of Glasgow. By Thomas Thomson, M. D. &c. *Lond. Edin. and Dub. Phil. Mag.* XVII. 407.

Composition. Silica 38.30, alumina 30.20, lime 13.54, soda 4.53, water 13.10 (*Berzelius*).

Geological Situation. In this country, as elsewhere, thomsonite has been found only in trappean rocks.

LOCALITIES.

Rockland County. In the rifts of greenstone at Piermont, there is a mineral which, in its external characters, closely resembles some varieties of thomsonite; and the latter mineral has been unhesitatingly credited to the similar formation at Bergen hill, New-Jersey.

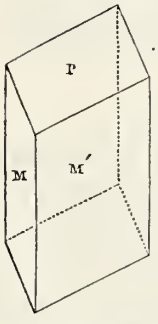
I will here only remark, that all the specimens which I have examined are clearly referable to another species, the *Stellite* of Thomson. But I do not wish to be understood as asserting that thomsonite has not been found at the localities in question. The above description has been introduced, and the doubts expressed, for the purpose of directing the attention of our mineralogists to the subject.

LAUMONITE.

[From its discoverer, M. Gilbert Laumont.]

Laumonite. *Haüy, Cleveland, Phillips, Beudant* and *Shepard.* — Lomonite. *Thomson.* — Diatomous Zeolite, or Laumonite. *Jameson.* — Diatomer Kuphon-Spath. *Mohs.*

Fig. 345.



Description. Colour white, passing into reddish, yellowish or greyish tints. It occurs regularly crystallized, and in distinct granular concretions. The primary form is an oblique prism, of which the inclination of the terminal plane is from one acute angle to the other. Fig. 345. M on M′ 86° 15′; M on P 113° 30′. Cleavage parallel to its lateral planes and both diagonals. Lustre vitreous, inclining to pearly upon the more distinct faces of cleavage. When fresh, it is transparent; but on exposure to the atmosphere, it very soon becomes opaque, and so soft as to yield to the pressure of the finger. Very easily frangible. Hardness 3.50, determined with difficulty (*Thomson*). Specific gravity from 2.20 to 2.30. Before the blowpipe, it loses water and melts into a spumous mass. It gelatinizes in acids, and becomes electric by friction, if insulated.

Composition. *A specimen from the Isle of Skye* — Silica 52.04, alumina 21.14, lime 10.62, water 14.92 (*Connel*).

LOCALITIES.

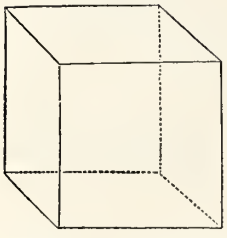
Putnam County. This mineral has been found in crystals of the primary form, associated with stilbite in feldspar in Phillipstown. The locality is believed to be exhausted. In Connecticut and Massachusetts, laumonite has been found in small quantities in amygdaloid. In Pennsylvania, it has been met with in fine crystals in Chester county.

ANALCIME.

[From the Greek α, privative, and αλκος, *strength;* in allusion to its weak electric virtue.]

Analcime. *Haüy, Cleaveland, Phillips, Beudant, Thomson* and *Shepard.* — Hexahedral Zeolite. *Jameson.* — Hexaedrischer Kuphon-Spath. *Mohs.*

Fig. 346.



Description. Colour white, grey and reddish white. It occurs regularly crystallized; also in angulo-granular concretions, and massive. Primary form a cube, Fig. 346. Cleavage parallel with the planes of that solid obtained with difficulty. Fracture uneven or conchoidal. Lustre shining, between vitreous and pearly. Ranges from transparent to translucent. Hardness 5.5. Specific gravity from 2.27 to 2.53. Before the blowpipe on charcoal, it fuses without intumescence into a clear glassy globule; with borax, it is very difficultly soluble. It gelatinizes in muriatic acid. The solution, after the separation of the silica, gives an abundant precipitate with ammonia. It becomes feebly electric by friction.

Analcime is distinguished from leucite, which it resembles, by the difference in crystalline form, and by its fusibility; and from garnet, by its inferior hardness and specific gravity. It wants the pearly lustre of stilbite and heulandite.

Composition. Silica 55.07, alumina 22.22, soda 13.71, water 8.22 (*Connel*).

Geological Situation. In New-York and New-Jersey, it occurs in veins in greenstone and gneiss, and is usually associated with other zeolitic minerals.

LOCALITIES.

Fig.347.

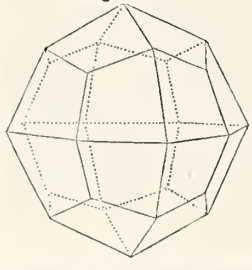
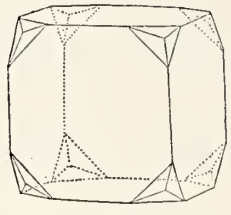


Fig. 348.



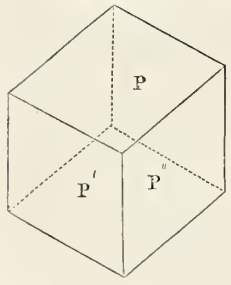
Westchester County. Small but very perfect trapezoidal crystals of analcime (Fig. 347) are found in the gneiss near Yonkers. It is associated with the *cuboide* form of calcareous spar and crystallized iron pyrites. Crystals of the same form also occur in the greenstone at Bergen hill, New-Jersey. Sometimes each angle of the cube is replaced by three planes, as in Fig. 348, by which twenty-four planes are added to it. When these twenty-four planes are increased to their utmost extent, so that no part of the primary planes is visible, the result is a solid bounded by twenty-four equal and similar trapeziums, called the icositetrahedron.

CHABAZITE.

[From the Greek χαξαζιος, though the application is not known.*]

Chabazie. *Haüy, Cleaveland, Beudant* and *Phillips.* — Chabazite. *Thomson.* — Rhombohedral Zeolite, or Chabazite. *Jameson.* — Rhomboedrischer Kuphon-Spath. *Mohs.*

Fig. 349.



Description. Colour white or greyish. It occurs regularly crystallized; seldom massive. Primary form an obtuse rhombohedron. Fig. 349. P′ on P″ 94° 46′. Cleavage parallel to the primary, but seldom distinct. Fracture conchoidal and uneven. Lustre externally splendent, internally glistening and vitreous. Hardness from 4.0 to 4.5. Specific gravity from 2.08 to 2.10. Before the blowpipe, it melts into a white frothy mass. Soluble by digestion in muriatic acid; solution precipitated by oxalate of ammonia. Gives out water by calcination.

This mineral sometimes resembles the obtuse rhombohedrons of calcareous spar, but the want of effervescence in acids will distinguish it. From several other of the trappean minerals, it differs in the action of acids, and of course in its crystalline form.

Composition. Silica 50.14, alumina 17.48, lime 8.47, potash with soda 2.58, water 20.83 (*Connel*).

Geological Situation. Like mesotype, stilbite, etc., this mineral is found in veins and cavities in trap, greenstone and gneiss.

LOCALITIES.

Putnam County. Chabazite, in the primary form, has been found at Coldspring, associated with stilbite. It is, however, of rare occurrence.

Rockland County. It occurs in the primary form, associated with other trappean minerals, in thin veins in the greenstone at Piermont. It has not yet, however, been found nearly so common as in the similar formation at Bergen hill in New-Jersey. The rhombohedrons are here usually minute, and may easily be mistaken for calcareous spar, which occurs in the greenstone in nearly the same form. The latter, however, wants the peculiar lustre of the chabazite, and effervesces freely with acids. The crystals of chabazite, at this locality, often have the edges and angles rounded as if by fusion.

Westchester County. Chabazite has been noticed near West-Farms, associated with stilbite, heulandite and epidote.

Chabazite is often met with in the trap region of the Connecticut river. It occurs also on mica slate at Chester, Mass., and at Hadlyme, Conn.

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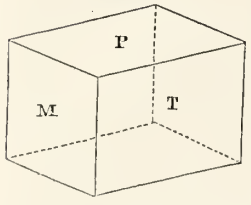
* Thomson. *Outlines of Mineralogy*, &c. I. 333.

EPIDOTE.

[From the Greek επιδιδωμι, *I increase;* in allusion to the increase which the base of the primary undergoes in some of the secondary forms (*Thomson*).]

Epidote. *Haüy, Cleaveland, Phillips, Thomson* and *Shepard.* — Prismatoidal Augite. *Jameson.* — Prismatoidischer Augit-Spath. *Mohs.* — Zoizite and Thallite. *Beudant.* — Pistazit. *Werner.*

Fig. 350.



Description. Colour green of different shades, occasionally almost black, rarely brown or reddish; also grey. Streak greyish white. It occurs regularly crystallized; also granular and massive. Primary form a right oblique angled prism. Fig. 350. M on T 114° 37′ (*Haüy*); 115° 30′ (*Phillips*). Cleavage perfect parallel to M; less so parallel to P. Fracture conchoidal, uneven and splintery. Lustre vitreous, inclining to pearly and resino-pearly. Semi-transparent to translucent on the edges. Brittle. Hardness from 6.0 to 7.0. Specific gravity from 3.42 to 3.44. Before the blowpipe, it intumesces, but does not, even by a strong heat, completely melt; with borax, it intumesces, and then fuses into a glass coloured by iron. It is not acted on by acids.

Varieties. The name *Epidote* or *Pistazite* is applied to all the green coloured varieties. It is both granular and crystallized.

Zoizite. This, which is sometimes described as a distinct species, has a grey, greyish yellow or brown colour. It occurs crystallized and massive. The prisms are often much compressed, striated, and sometimes rounded. When massive, it is not unfrequently composed of broad fibres slightly diverging. It differs from epidote principally in its colour.*

Manganesian Epidote. This occurs in small prismatic crystals of a violet or reddish brown colour. It contains about twelve per cent. of the oxide of manganese; and before the blowpipe, it fuses into a black glass; with borax it exhibits the characteristic amethystine tint of manganese.

Composition. *Epidote* (*green*)—Silica 37.00, alumina 27.00, lime 14.00, oxide of iron 17.00, oxide of manganese 1.50 (*Decotils*).

Zoizite (*grey*)—Silica 45.00, alumina 29.00, lime 21.00, oxide of iron 3.00 (*Klaproth*).

Geological Situation. It is found almost exclusively in primary rocks, as gneiss, mica slate, sienite and white limestone.

LOCALITIES.

Clinton County. Massive epidote is found in small quantities at the Arnold iron mine.

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* I have recently seen an article, probably written by R. Phillips, in which it is stated that the crystalline form of zoizite is the same as that of cuclase, and has not a single face or cleavage in common with epidote. *Lond. Edin. and Dub. Mag.* &c. XX. 442.

Dutchess County. In the town of Rhinebeck, granular epidote occurs in a ferruginous green feldspar; and it is also said to have been found at Hudson, in Columbia county.*

Essex County. Epidote, in small imperfect crystals of a fine greenish yellow colour, is found associated with quartz, feldspar and mica, in the town of Crown-Point, and about five miles north of the village of Alexandria.

New-York County. This mineral occurs in small yellowish green and very beautifully finished crystals, in gneiss at Harlem, on the banks of the East river, near 38th-street, and in other parts of the island. The most common forms of these crystals are represented in Fig. 351, *bisunitaire* of Haüy, and Fig. 352.

Fig. 351.

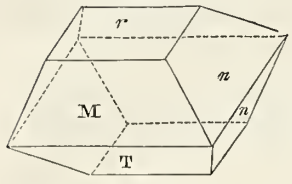
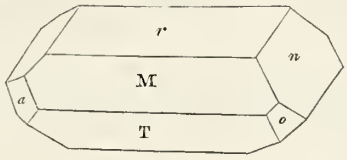
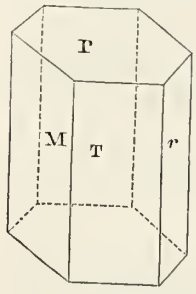


Fig. 352.



M on T 115° 30′; M on *r* 116° 40′; *n* on *n* 109° 10′; *n* on *r* 125° 25′; M on *o* 121° 23′ (*Haüy* and *Beudant*).

Fig. 353.



Orange County. At Bog Meadow pond in the town of Cornwall, there is a locality of massive and somewhat fibrous epidote of a fine greenish yellow colour.

About two miles north of Coffee's, in the town of Monroe, it is in dark grass-green crystals in granite. The forms are the primary and the six-sided prism, Fig. 353.

Six miles west of the village of Warwick, the massive variety occurs of a pale yellowish green colour. It is associated with sphene and pyroxene.

Fig. 354.

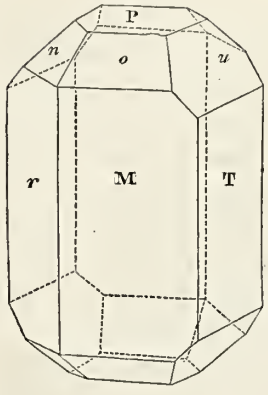
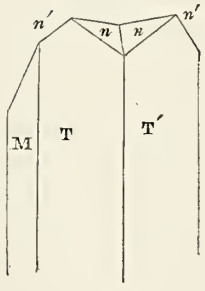


Fig. 355.



Two miles southeast of Amity, crystallized epidote occurs in a vein in quartz. The crystals are often very perfect, and have a rich grass-green colour. The forms are those represented in Fig. 351; Fig. 354, the *monostique* of Haüy; and the twin, Fig. 355, similar to that figured by Shepard as from Franconia in New-Hampshire. The axis of revolution is parallel to the prismatic axis, and the angle of revolution 180°. M on T 115° 30′; *n* on *n′* 109° 10′.

Fig. 354. M on *r* 116° 40′; M on *o* 121° 23′; P on *n* 144° 35′; P on *o* 148° 37′; P on *u* 125° 35′ (*Haüy*).

* *Cleaveland's Mineralogy.*

Putnam County. Epidote has been found near Coldspring, in this county. There is a locality in the town of Southeast, about two miles south of the village of Carmel, where both the massive and crystallized varieties have been obtained. The crystals are translucent, of a beautiful green colour, and from a quarter to three quarters of an inch in length. They are usually six-sided prisms, but the terminations are seldom perfect. The associates are hornblende, garnet, etc.

Rockland County. This mineral is found in small granular masses, associated with feldspar and actynolite, at Montaigne's marble quarry, two and a half miles west of Grassy point.

Saratoga County. Epidote has been credited to the town of Moreau.

Warren County. The common massive variety is found in gneiss at Sabbath Day point on Lake George.

Washington County. Epidote occurs in small but imperfect translucent crystals of a yellowish colour, on the banks of Lake George in the town of Putnam, two miles south of Alexandria.

Westchester County. Near West-Farms, it is met with in granular masses and in crystals.

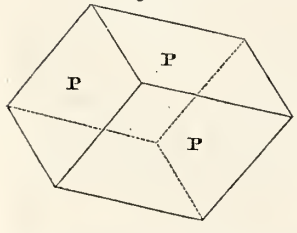
In Vermont, zoizite occurs at Montpelier and Wardsborough; in Massachusetts, at Goshen and Williamsburgh; and in Connecticut, at Milford. Fine crystals of epidote occur at Haddam in Connecticut.

TOURMALINE.

(Said to be a corruption of the Ceylon name for this mineral.)

Tourmaline. *Haüy, Phillips, Thomson, Beudant* and *Shepard.* — Schorl. *Cleaveland.* — Rhombohedral Tourmaline. *Jameson.* — Rhomboedrischer Turmaline. *Mohs.* — Turmaline. *Dana.*

Fig. 356.



Description. Colour black, brown, green, blue, red and white. Occurs regularly crystallized; also massive and disseminated. Primary form an obtuse rhombohedron. Fig. 356. P on P 133° 26′. It is usually found in prisms of three, six, nine and twelve sides, and terminated by very irregular summits. Cleavage difficult. Fracture uneven and imperfect. Lustre vitreous. From transparent to opaque. Brittle and easily frangible. Hardness from 7.0 to 7.5. Specific gravity from 3.00 to 3.42. Before the blowpipe, the black variety intumesces and becomes a black scoriaceous mass; the green variety intumesces, but does not fuse. With borax, it fuses into a transparent glass.

Tourmaline possesses the property of exhibiting different colours, according as it is viewed parallel or perpendicular to the axis of its crystals, and it is almost invariably less transparent in the first of these directions than in the last. It becomes electric when heated; and according to Haüy, the termination which presents the greatest number of planes always exhibits the positive or vitreous electricity, while that which consists of the smaller number

indicates the negative or resinous. It is said that the finest transparent crystals, especially when cut by the lapidary, are constantly electric, without artificial heat.

Its property of becoming electric by heat, and its vitreous conchoidal fracture, will distinguish tourmaline from several varieties of hornblende, some varieties of which it often resembles. Allanite, which it also resembles, forms a jelly with muriatic acid.

Varieties. *Schorl.* This term is often applied to the black opaque specimens with an uneven fracture.

Indicolite. This has the crystalline forms of the other varieties, but has an indigo-blue colour.

Rubellite. This includes those crystals which are of various shades of red; and sometimes they are violet. The colour is owing to the presence of a minute portion of oxide of manganese.

Composition. The analysis of this mineral is exceedingly difficult.

Black Tourmaline—Silica 34.48, alumina 34.75, soda 1.75, potash 0.48, oxide of iron 17.44, oxide of manganese 1.89, boracic acid 4.02, magnesia 4.68 (*Gmelin*).

Blue Tourmaline—Silica 40.30, alumina 40.50, oxide of iron 4.85, oxide of manganese 1.50, boracic acid 1.10, lithia 4.39 (*Arfwedson*).

Green Tourmaline—Silica 39.16, alumina 40.00, oxide of iron 5.96, oxide of manganese 2.14, boracic acid 4.59, lithia 3.59 (*Gmelin*).

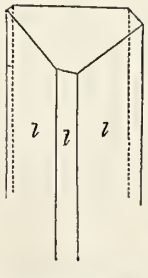
Red Tourmaline—Silica 39.37, alumina 44.00, potash 1.29, oxide of manganese 5.02, boracic acid 4.18, lithia 2.62 (*Gmelin*).

Geological Situation. Tourmaline is almost always found in primary rocks, as coarse granite, gneiss, mica slate, chlorite slate, dolomitic and common white limestone.

LOCALITIES.

Dutchess County. Tourmaline is said to have been found at Rhinebeck in this county.*

Fig. 357.



Essex County. The brown variety is found in white limestone, in the immediate vicinity of Port Henry. It is usually in six-sided prisms, with the alternate planes very narrow. Fig. 357. *l* on *l* 120°. The black variety occurs imperfectly crystallized in quartz, in Ticonderoga. The same variety is associated with fibrous phosphate of lime, near Hammondsport in Crown-Point.

Jefferson County. On the banks of Vrooman lake, near Oxbow, tourmaline, in imperfect crystals, is found associated with mica and pyroxene. It is not abundant.

On High island, in the St. Lawrence, opposite to Alexandria, there occur long and large prisms with many sides, irregularly grouped, but the crystals are seldom sufficiently perfect for measurement.

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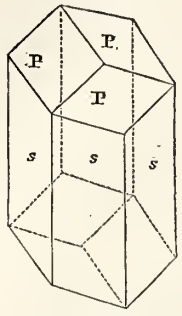
* Schæffer. *Cleaveland's Mineralogy.*

Herkimer County. The black variety is sometimes found with quartz crystals.

Fig. 358.



New-York County. At Kingsbridge, brown, yellowish or reddish brown crystals are found in the dolomitic limestone. They are sometimes in the form of six-sided prisms with three terminal planes, Fig. 358; at others, the prisms have nine sides, with various terminations. It is associated with reddish brown mica.* The blue and black varieties occur in the granitic beds or veins in various parts of the island. Many fine specimens were obtained from the tunnel of the Harlem railroad.

Orange County. Tourmaline of various colours, and often well crystallized, is found in various parts of the town of Warwick. One and a half miles north of the village of Edenville, it is grey or bluish grey, and is in the form of three-sided prisms. In the same vicinity, it is green, and also in three-sided prisms without regular terminations, Fig. 359.

Fig. 359.

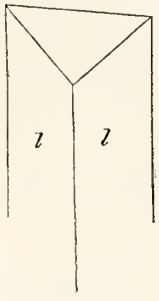


Fig. 360.

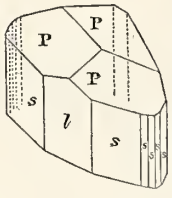
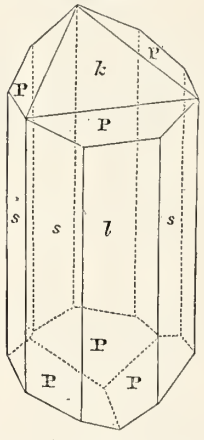


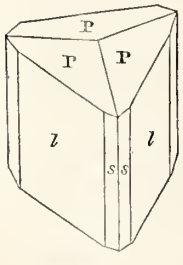
Fig. 361.



A mile north of the same village, black and imperfect crystals are found, sometimes half an inch in diameter, and from a sixteenth to a quarter of an inch in length. They sometimes have the form represented in Fig. 360. The *nonoseptimale* of Haüy, Fig. 361, having a black colour, also occurs in this vicinity; and one mile northwest of Edenville, brown crystals are sometimes met with. P on *l* 117° 9′; P on *s* 113° 13′; P on *k* 152° 51′; *k* on *l* 90°; *k* on *s* 90°; *l* on *l* 120°; *l* on *s* 150°; *s* on *s* 120° (*Haüy*).

At Rocky hill, in the same town, black imperfect crystals are found in quartz. They are sometimes from three to five inches in diameter.

Fig. 362.



About a mile and a half southwest of the village of Amity, there are crystals of tourmaline, associated with spinelle, in calcareous spar. The colours are yellow, yellowish brown and cinnamon-red. The crystals are sometimes more than an inch in length. One of the forms is a triangular prism with the angles bevelled, Fig. 362.

Again the same mineral, having a clove-brown colour, occurs associated with grey hornblende, rutile, quartz, etc. in a vein of white limestone near the village of Amity.

* *Cleaveland's Mineralogy.*

Fig. 363.

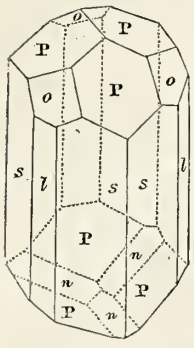
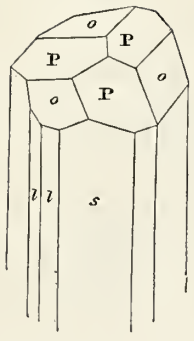


Fig. 364.



St. Lawrence County. Near the village of Gouverneur, crystals of tourmaline have been found, varying from one inch to several inches in length, and from one to four inches in diameter. The colours are light reddish brown, cinnamon and dark brown, and they are associated with apatite, scapolite, mica, etc. in white limestone. The *nonoduodécimale* of Haüy, Fig. 363, and the form Fig. 364, have been found at this locality; but it is difficult to obtain perfect crystals. P on *o* 141° 40′; P on *n* 156° 43′; *l* on *o* 135° 44′; *o* on *o* 103° 20′ (*Haüy*).

At Richville, in the town of Dekalb, brown tourmaline, in perfect crystals, associated with tremolite, occurs in the soft and tough pyroxene and white limestone. The crystals are very brittle; and this, together with the peculiar toughness of the gangue, renders it exceedingly difficult to obtain perfect crystals.

Eight miles from Potsdam, on the road to Pierrepont, tourmaline is said to have been found in crystals three inches in diameter.*

Saratoga County. One of the most interesting localities of tourmaline in this State, is in the town of Greenfield, about a mile north of Saratoga-Springs. The mineral is of a jet black colour, often having the sides and terminations highly finished. The crystals are usually small, and are associated with garnet, chrysoberyl, feldspar, apatite and mica, in quartz or a very coarse granite which forms a vein in gneiss. The following forms have been observed at this locality, viz: Fig. 362; Fig. 365, the *isogone* of Haüy; Fig. 366, the same with the additional plane *l*; Fig. 367, *tredécimale* of Haüy; Fig. 368, a modification of the preceding;

Fig. 365.

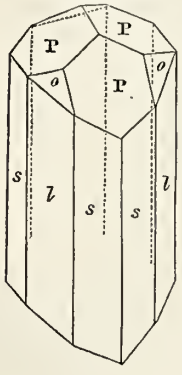


Fig. 366.

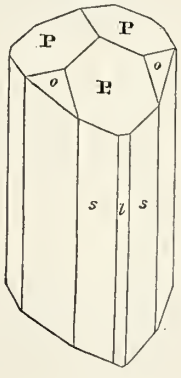


Fig. 367.

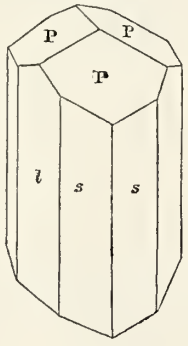
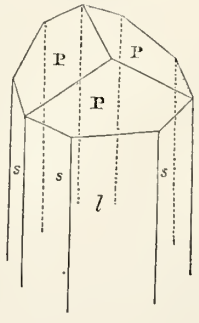


Fig. 368.



* I. Finch. *American Journal of Science*, XIX. 220.

Figs. 369, 370, 371, 372, the latter a flattened crystal.

Fig. 369.

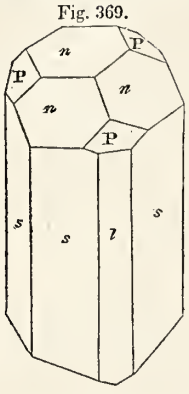


Fig. 370.

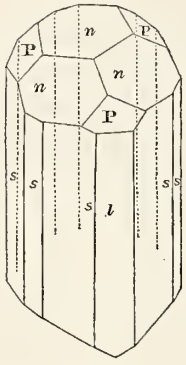


Fig. 371.

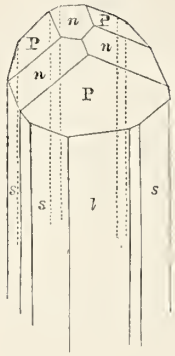
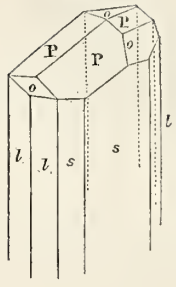
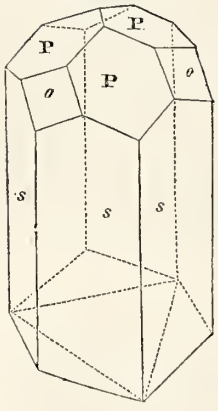


Fig. 372.



P on *l* 117° 9′; P on *n* 156° 43′; P on *o* 141° 40′; P on *s* 113° 13′; *n* on *n* 155° 9′; *n* on *s* 102° 26′; *o* on *o* 103° 20′ (*Haüy*).

Fig. 373.



Westchester County. Black tourmaline is found in the gneiss on the Croton aqueduct, near the village of Yonkers; but the crystals are seldom perfect. In a granitic bowlder near New-Rochelle, I found a crystal of a jet black colour, the summit of which is that of the *sexdécimale* of Haüy, Fig. 373.

Warren County. Brown tourmaline has been found in this county. A fine crystal of this kind has the form of Fig. 258. It is in the possession of Dr. Emmons, but I am unacquainted with the precise locality.

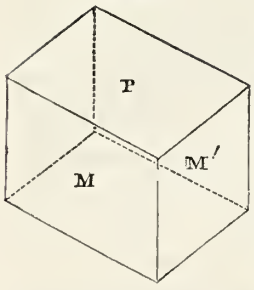
The black variety is found massive, and in large imperfect crystals, associated with feldspar, in the mountains in the vicinity of the village of Caldwell.

CLINTONITE.

[In honour of the late Governor De Witt Clinton.]

Bronzite. *Shepard.* — Seybertite. *Clemson, Dana, Mohs* App. — Holmesite. *Thomson.* — Rhomboedrischer Perl-Glimmer. *Mohs.*

Fig. 374.



Description. Colour copper-red, reddish brown, yellowish brown and reddish white. Streak yellowish grey. It occurs imperfectly crystallized, also in foliated masses. Primary form an oblique rhombic prism. Fig. 374. M on M′ about 94°. Cleavage parallel with planes tangent to the angles of the base, perfect; with the primary faces imperfect (*Breithaupt*). Lustre metallic pearly. Opaque to translucent; in thin laminæ, sometimes transparent. Hardness from 4.0 to 4.5. Specific gravity from 3.07 to 3.10. Infusible alone by the blowpipe; with carbonate of soda and borax, it melts into a transparent white pearl. When reduced to an impalpable powder, it is attacked by acetic, nitric, muriatic and sulphuric acids (*Clemson*).

This mineral resembles some varieties of mica, but it is with difficulty separable into laminæ, and these laminæ are scarcely flexible even when very thin. It is also harder than mica. From bronzite it differs entirely in its chemical composition.

Composition. This mineral has been analyzed both by Mr. Clemson and Dr. Thomson, with somewhat different results. These are as follows:

Silica,	17.00	....	19.35
Alumina,	37.60	....	44.75
Magnesia,	24.30	....	9.05
Lime,	10.70	....	11.45
Protoxide of iron,	5.00	....	
Water,	3.60*	....	4.55
Peroxide of iron,			4.80
Zirconia,			2.05
Oxide of manganese,			1.35
Fluoric acid,			0.90†

localities.

Orange County. The present mineral has hitherto been found only near the village of Amity, and about a mile southwest; at one of which localities, it occurs in calcareous spar; and at the other, in serpentine and white limestone. It is associated with spinelle, a peculiar variety of talc, and some other crystalline minerals. Dr. Horton remarks that it often com-

* Clemson. *American Journal of Science.* XXIV. 171.

† Thomson. Ibid. XXXI. 170.

pletely invests large spinelles, and sometimes with such regularity that it might be mistaken for a real octahedron of clintonite.

This mineral was discovered about fifteen years since, and named *Clintonite*, by Messrs. J. Finch and Mather and Dr. Horton. I soon afterwards examined it, and satisfied myself that it was a distinct species, although I did not go through a complete analysis. It was subsequently analyzed by Mr. Clemson as above stated, and named by him *Seybertite*. Still more recently, Dr. Thomson examined the mineral, and arriving at the same conclusion in regard to its being a distinct species, gave it the name of *Holmesite*, in compliment to Dr. A. F. Holmes of Montreal. Mohs describes it in the body of his work, under the trivial name of *Clintonite;* and in his appendix, introduces *Seybertite* as if distinct. The name Clintonite was given to it by the discoverers in honor of De Witt Clinton; and as all the subsequent examinations have proved their opinion that it was a distinct species, to have been correct, it seems to be proper that this name should be retained. It has been generally adopted by the German mineralogists, and those of New-York certainly will not hesitate to follow the example.

Fig. 375.

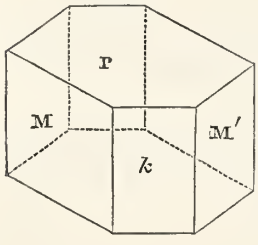
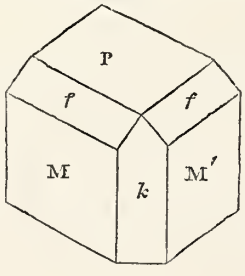


Fig. 376.



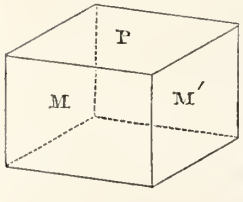
Figs. 375 and 376 represent the secondary crystalline forms observed by Dr. Horton. The measurements have not been ascertained.

ANDALUSITE.

[From its having been first found in *Andalusia* in Spain.]

Macle. *Haüy* and *Cleaveland.* — Andalusite. *Shepard.* — Andalusite and Chiastolite. *Phillips.* — Andalusite, or Disilicate of Alumina. *Thomson.* — Andalousite. *Beudant.* — Prismatic Andalusite. *Jameson.* — Prismatischer Andalusit. *Mohs.*

Fig. 377.



Description. Colour red and grey. Streak white. It occurs regularly crystallized, and massive. Primary form a right rhombic prism. Fig. 377. M on M′ 91° 20′. Cleavage parallel with M on M′, distinct. Fracture uneven. Lustre vitreous. Feebly translucent. Hardness 7.5. Specific gravity 3.104. Before the blowpipe, it is infusible alone; with borax, it fuses with great difficulty, and only when reduced to powder, into a transparent colourless glass. It is not acted on by acids.

The species formerly known under the name of *Macle* or *Chiastolite*, is now thought to be a mixed mineral, consisting of andalusite and the materials of clay slate, which assumes a variety of compound forms.

In an interesting paper on this subject by Dr. Charles T. Jackson, it is shown that there is an insensible gradation from those which have the lowest degree of hardness, to those crystals which have the hardness of andalusite. The following are some of the forms which are figured by Dr. Jackson, from specimens obtained at Lancaster in Massachusetts.* Figs. 378, 379, and 380.

Fig. 378.

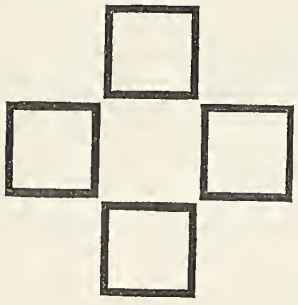


Fig. 379.

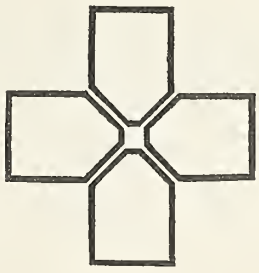


Fig. 380.

Composition. Alumina 60.50, silica 36.50, oxide of iron 4.00 (*Bucholz*). Alumina 60.20, silica 35.30, protoxide of iron 1.32, magnesia 1.00, water 2.03 (*Thomson*).

Variety. *Chiastolite* — Alumina 61.00, silica 33.00, protoxide of iron 4.00, water 1.50 (*Jackson*).

Geological Situation. Andalusite occurs only in primitive strata, especially in mica slate; also in gneiss and clay slate.

LOCALITIES.

Rockland County. Specimens of this mineral have been found in bowlders of mica slate near Nyack. These bowlders were thought to have been transported from Westchester county. It will undoubtedly be hereafter found in the rocks of Westchester and Rockland, along with staurotide and garnet.

In Massachusetts, fine specimens have been obtained in the towns of Lancaster and Sterling; and in Connecticut, at Litchfield.

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* *Boston Journal of Natural History.* I. 55.

BUCHOLZITE.

[In honor of Bucholz, a distinguished German chemist.]

Bucholzite. *Cleaveland*, *Phillips* and *Shepard*. — Bucholzite, or Anhydrous Silicate of Alumina. *Thomson*. — Fibrolite. *Mohs* App. — Appendix to Sillimanite. *Beudant*.

Description. Colour greyish white, with a very slight tinge of yellow. Structure fibrous. The fibres are sometimes bent, and when viewed through a microscope, assume the appearance of plates or imperfect prismatic crystals. Lustre silky. Hardness 6.0. Specific gravity 3.19.

Composition. *Specimen from Chester, Pennsylvania*—Silica 46.40, alumina 52.92 (*Thomson*).

From the Tyrolese Alps—Silica 46.00, alumina 50.00, protoxide of iron 2.50, potash 1.50 (*Brandes*).

Both Beudant and Shepard seem to consider the sillimanite to be identical with bucholzite, but the chemical composition of these two minerals is too widely dissimilar to admit such an union. Further analyses, however, may remove this difficulty. I am more disposed to adopt the views of Mohs in regard to the identity of fibrolite with bucholzite, as this, like the latter, is a simple silicate of alumina, containing from 33 to 38 of silica and from 46 to 58 of alu mina, with some iron. They also agree very well in their other characters.

In the above description, I have followed Dr. Thomson, by whom it was drawn from the fine specimens obtained at the locality in Chester, Penn.

LOCALITIES.

Orange County. This mineral occurs associated with quartz and mica, near the Queensbury forge in the town of Monroe. The fibres are straight or slightly contorted, of a white or greyish white colour, and resinous lustre. They are very hard, but it is difficult to determine their crystalline form. Specimens from this locality exactly resemble those from Norwich in Connecticut.

According to Dr. Horton, there are several other localities in the same town.

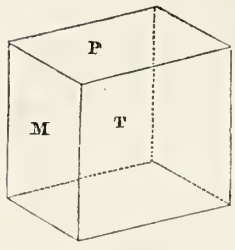
In Connecticut, bucholzite has been found at Humphreysville, while the variety or species sillimanite occurs at Chester in the same State.

KYANITE.

[From the Greek κυανος, *blue;* on account of its blue colour.]

Cyanite. *Cleaveland.* — Disthene. *Haüy* and *Beudant.* — Cyanite, or Sesquisilicate of Alumina. *Thomson.* — Prismatic Kyanite. *Jameson.* — Prismatischer Disthen-Spath. *Mohs.* — Kyanite. *Phillips, Shepard* and *Dana.* — Sappare. *Saussure.*

Fig. 381.



Description. Colour white, grey, blue, and bluish-green. Streak white. It occurs regularly crystallized; also massive and disseminated. Primary form a doubly oblique prism. Fig. 381. P on M 93° 15′; P on T 100° 50′; M on T 106° 15′. Cleavage distinct parallel with M and T; difficult parallel with P. Fracture uneven. Lustre pearly. Varies from transparent to translucent. Brittle. Hardness from 5.0 to 7.0. Specific gravity from 3.50 to 3.70. Before the blowpipe, even its powder is infusible, and it remains unaltered in very high degrees of temperature; with borax, it fuses with great difficulty into a transparent colourless glass. It is not acted on by acids.

Varieties. *Kyanite.* This includes those specimens which have a blue colour.
Rhætizite is the white or somewhat reddish variety, occurring in aggregated masses.

Composition. *Kyanite*—Alumina 64.30, silica 34.33 (*Arfwedson*). Alumina 67.80, silica 31.60, lime 0.20 (*Beudant*).

Geological Situation. This mineral occurs exclusively in primitive rocks, and especially in the granitic white limestone.

LOCALITIES.

New-York County. Kyanite has been found in loose masses of granite near the city.* They are usually, however, of an inferior quality.

Orange County. Dr. Horton refers to some localities in the towns of Warwick and Monroe, but these minerals are probably more nearly allied to bucholzite than to the present species.

In Massachusetts, there is a fine locality of kyanite at Chesterfield, where it is associated with garnet in mica slate.

In Pennsylvania, fine specimens of kyanite have recently been found in Delaware county.

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* Cozzens. *American Journal of Science.* X. 200.

ACHMITE.

[From the Greek $\alpha\chi\mu\eta$, *the point of a sword;* from the pointed form of the crystals.]

Achmite. *Phillips, Thomson, Shepard* and *Beudant.*

Fig. 382.

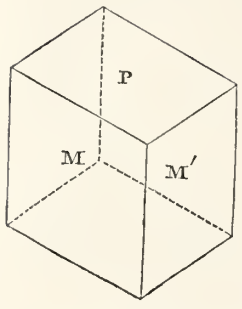
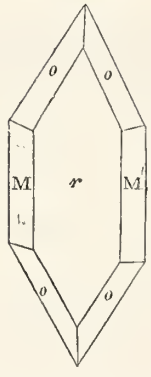


Fig. 383.



Description. Colour varying from brownish black to greenish grey. Streak pale yellowish grey. It occurs crystallized. Primary form an oblique rhombic prism. Fig. 382. M on M′ 93° 4′. But it usually occurs in the form represented in Fig. 383, the obtuse lateral edges being deeply truncated, forming a six-sided prism terminated by a four-sided pyramid. Cleavage perfect parallel with M; less so parallel with the diagonals. Fracture imperfectly conchoidal. Lustre vitreous. Varies from opaque to translucent on the edges. Hardness from 6.0 to 6.5. Specific gravity from 3.40 to 3.50. Alone before the blowpipe, it fuses into a black bead, which is attracted by the magnet. It is not attacked by acids.

This mineral has been referred to pyroxene, some varieties of which it quite closely resembles. It differs, however, in chemical composition, the proportion of lime in achmite being very minute.

Composition. Silica 55.25, protoxide of iron 31.25, soda 10.40, protoxide of manganese 1.08, lime 0.72 (*Berzelius*).

LOCALITIES.

Achmite was first found in large crystals in feldspar and quartz, at Rundemyr near Kongsberg in Norway. A mineral closely resembling it in all the characters which I have had an opportunity of determining, is found in long hair-like prisms running through crystals of calcareous and pearl spar, at Lockport in Niagara county. These crystals are striated longitudinally, have a high vitreous, almost metallic, lustre, sometimes tarnished. Colour brownish. Fusible by the blowpipe alone into a black globule, which is attracted by the magnet. It has not been obtained in quantity sufficient for chemical analysis.

The above mineral has been called *rutile,* to which it is not unlike in its external characters; but rutile is not fusible by the blowpipe.

PITCHSTONE.

[From its resemblance to some varieties of *pitch*.]

Pitchstone. *Cleaveland, Phillips* and *Shepard*. — Petrosilex, Resinite. *Haüy*. — Variety of Quarz. *Beudant*. — Fusible Quartz, Obsidian, Pitchstone, Pearlstone, Pumice. *Jameson*. — Empyrodoxer Quarz. *Mohs*.

Description. Colour grey, blue, green, yellow, brown and black, but usually dull. Streak white. It is destitute of regular form or cleavage; occurs massive, vesicular and porous. Fracture conchoidal, sometimes imperfect. Lustre vitreous, resinous and pearly. Varies from transparent to opaque. Hardness from 6.0 to 7.0. Specific gravity from 2.21 to 2.39. Before the blowpipe, the different varieties of this mineral melt with various degrees of facility, into a vesicular glass or enamel.

Varieties. *Obsidian*. This has a splendent vitreous lustre and conchoidal fracture.

Pitchstone. A variety with a shining and resinous lustre, and translucent on the edges.

Pearlstone. This name is applied to the varieties which occur in globular, pearly, translucent concretions.

Pumice. White and grey, vesicular and fibrous, with a pearly lustre, and often so light as to swim on water.

Composition. *Obsidian* — Silica 78.00, alumina 10.00, lime 1.00, potash 6.00, oxide of iron 3.60 (*Vauquelin*).

Pitchstone — Silica 72.80, alumina 11.50, soda 2.85, lime 1.20, oxide of iron 3.03, water and bituminous matter 0.50.

Pearlstone — Silica 77.00, alumina 13.00, potash 1.50, lime and soda 2.70, oxide of iron and manganese 2.00, water 4.00 (*Vauquelin*).

Pumice — Silica 77.50, alumina 17.50, soda and potash 3.00, oxides of iron and manganese 1.75 (*Klaproth*).

Geological Situation. Pitchstone, in all its varieties, is usually found in volcanic districts, or forming beds or veins in rocks of igneous origin.

LOCALITIES.

Essex County. This mineral is found in the trappean dykes of Essex and Warren counties. The colour is black or bluish black. It has a vitreous lustre, and fuses alone into a black globule.

Some years since, Dr. G. Troost described a mineral which belongs to this species, found by Lieut. Bayfield on the north shore of Lake Superior, near the island of St. Ignatius. It was adhering to one of the quadrilateral columns of the trappean dykes which so frequently traverse the hornblendic granites of that region. This mineral is opaque, has a perfectly black colour and small conchoidal fracture, a resinous lustre, and a hardness sufficient to

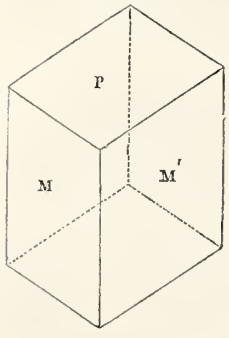
scratch glass. Before the blowpipe, it foams up at once, becomes brown, and by a continued heat is brought to the state of a black opaque scoria. Its specific gravity is 2.41, and it contains silica 78.25, alumina 12.75, alkali 8.00, together with some oxide of iron and water.*

SPODUMENE.

[From the Greek σποδος, *ashes*; in allusion to the change which it undergoes before the blowpipe.]

Spodumene. *Cleaveland, Phillips, Thomson* and *Shepard.* — Triphane. *Haüy* and *Beudant.* — Prismatic Spodumene. *Jameson.* — Prismatischer Triphan-Spath. *Mohs.*

Fig. 384.



Description. Colour greenish white and greyish green. Streak white. It occurs massive and in large granular concretions. Cleaves in the direction of an oblique rhombic prism, which is its primary form. Fig. 384. M on M′ 93°. Fracture uneven. Lustre shining and pearly. Translucent. Very easily frangible. Hardness from 6.5 to 7.0. Specific gravity from 3.11 to 3.19. Before the blowpipe, it swells to a foliated reddish yellow mass, which on the smallest agitation falls to powder. The outermost portions fuse into small glassy globules (*Thomson*).

Composition. Silica 66.49, alumina 25.30, lithia 8.85, oxide of iron 1.45 (*Arfwedson*).

Geological Situation. It occurs in primitive rocks, especially in granite.

Saratoga County. Spodumene was said by Dr. Steele to occur near Saratoga Springs, associated with reddish feldspar, black mica and quartz; but it may be that some other mineral has been mistaken for this, as I am not aware that it has been found by any other mineralogist. It occurs at Goshen, Massachusetts, and in the towns of Chesterfield and Sterling in that State. It resembles pyroxene, but can easily be distinguished by its behaviour before the blowpipe.

PYROPHYLLITE.

[From the Greek πυρ, *fire*, and φυλλον, *a leaf.*]

Pyrophyllite. *Phillips, Thomson*, and *Mohs* (App.)

Description. Colour white or greenish white. It occurs in fibrous radiating masses, and small elongated prisms whose form has not been determined. Cleavage indistinct, rectangular. Lustre pearly. Hardness 1.5. Specific gravity 2.80. Before the blowpipe, it spreads out in a fan-like shape, and increases to twenty times its former bulk; with borax, it forms a green transparent glass. When heated with nitrate of cobalt, it assumes a blue colour.

* Troost. *Journal of the Academy of Natural Sciences of Philadelphia.* V. 55.

Composition. Silica 59.79, alumina 29.46, magnesia 4.00, peroxide of iron 1.80, water 5.62 (*Hermann*).

This mineral was first found in the Ural mountains, and received the name of *fibrous talc*. It was analyzed by Hermann of Moscow. It differs from talc in its behaviour before the blowpipe.

LOCALITY.

According to Mr. Mather, it occurs near West-Point, in a vein a foot in width, traversing grey pyroxene. A fragment of it, an eighth of an inch in thickness, exfoliates by heat to such a degree as to become an inch thick.*

MICA.

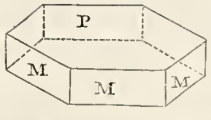
[From the latin *mico, to shine;* in allusion to its lustre.]

Under this name have heretofore been included two or three distinct species.

MONO-AXIAL MICA.

Rhombohedral Talc-Mica. *Jameson.* — Rhomboedrischer Talc-Glimmer. *Mohs.*

Fig. 385.



Description. Colour generally dark green and brown; sometimes also black. Streak white or grey. It occurs in regular six-sided prisms, which cleave with great facility in a direction perpendicular to the axis, Fig. 385. It exhibits one axis of double refraction. Lustre pearly, inclining to metallic on the terminal faces of the prism. From transparent to opaque. Sectile. Folia very flexible and elastic. Hardness from 2.0 to 2.5. Specific gravity from 2.80 to 3.00. Before the blowpipe, it sometimes fuses into a scoria, but generally only becomes white and opaque.

Composition. Silica 42.50, alumina 16.05, magnesia 25.97, potash 7.55, oxide of iron 4.93 (*Rose*).

Black from Siberia.—Silica 42.50, alumina 11.50, magnesia 9.00, potash 10.00, oxide of iron 22.00, oxide of manganese 2.00 (*Klaproth*).

Geological Situation. It occurs in primitive districts, and in the ejected debris of Vesuvius. It is also found in the basalts of the Rhine; but it is by no means so abundant as the following.

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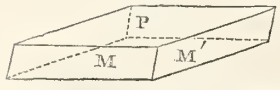
* Mather. *American Journal of Science.* XXI. 97.

DI-AXIAL MICA.

Hemiprismatic Talc-Mica, or Common Mica. *Jameson.* — Hemiprismatischer Talc-Glimmer. *Mohs.*

Fig. 386.



Description. Colour white, grey, green, yellow, red, brown and black. Streak white or grey. It occurs in oblique rhombic prisms, with transverse sections of about 120° and 60°, Fig. 386. Cleavage parallel to the base. It exhibits two axes of double refraction. Lustre pearly. Transparent and translucent. Sectile. Flexible and elastic. Hardness from 2.0 to 2.5. Specific gravity 2.80 to 3.00. Before the blowpipe it loses its transparency, but does not fuse, except when it contains lithia, when it melts easily, and at the moment of fusion gives the flame a reddish tinge.

Composition. *Specimen from Zinwald.* — Silica 47.00, alumina 20.00, potash 14.50, oxide of iron 15.50, oxide of manganese 1.75 (*Klaproth*).

Red or *Lepidolite Mica.* — Silica 50.35, alumina 28.30, potash 9.04, oxide of manganese 1.23, fluoric acid and water 5.20, lithia 5.49 (*Turner*).

From Orange county, N. Y. — Silica 49.38, alumina 23.67, peroxide of iron 7.31, lime 6.13, potash 15.29, lithia 0.06 (*Thomson*).

Geological Situation. This species forms an essential constituent of granite, gneiss and mica slate. It is also sometimes found in transition and secondary rocks. In some parts of Russia, it occurs in plates of a yard or more in diameter, and is known by the name of *Muscovy glass*.

LOCALITIES.

The localities of mica in this State are of course very numerous, as the mineral occurs in all the primitive districts. I shall here notice only those which are the most interesting.

Essex County. Mica, in dark coloured plates of moderate size, occurs at the Crag Harbour mine, associated with hornblende and magnetic iron ore. It is also found, of the same dark colour, at many of the other iron mines in the vicinity of Port Henry. It is of common occurrence in several other towns of this county.

Jefferson County. There is a locality near Henderson, where a yellow or somewhat copper-coloured variety of mica is met with, both in plates and in regular six-sided tables of large size.

The dark copper-coloured variety is found on the farm of Mr. Wait, in the town of Antwerp, four and a half miles south of the village of Oxbow.

On the banks of Vrooman lake, near the village of Oxbow, it occurs, in six-sided prisms or tables of a light copper colour. The crystals are from half an inch to two inches in diameter, and generally taper gradually towards one of the terminations. Sometimes they exhibit a cleavage parallel to the longer axis, and the hexagon separates into two pentagonal tables,

Fig. 387.

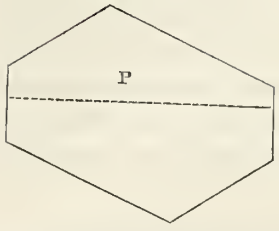


Fig. 388.

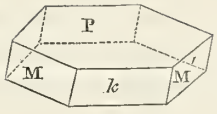


Fig. 387. The angles of the crystal are about 119°.

Near the banks of Muscolunge lake, in the town of Alexandria, this mineral is found in small but regular and perfect six-sided tables of a dark brown colour, in white limestone. Fig. 388. M or M′ on *k* 120°.

The plumose variety of mica has also been found associated with spinelle in white limestone, near the village of Oxbow.

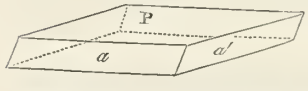
New-York County. The dolomite at Kingsbridge, and elsewhere, contains mica, which is sometimes in the form of perfect six-sided tables. It exhibits a variety of colours. The plates are seldom of large size.

Orange County. Mica of almost every variety of colour and form occurs in this county. Many of the localities are of great interest. One of these perhaps most deserving of notice, is on the bank of a stream running from Mount Basha pond, near Forshee's iron mine, in the town of Monroe. The mica is in augite rock, or rather in a bed of this mineral, with scattering crystals of quartz contained in gneiss. The plates interlace each other in various directions, and some of them are of large size. Dr. Horton and myself obtained a specimen, now in the State Cabinet, which is twenty-two inches in diameter; but plates of nearly three feet in diameter have been observed at the locality. They are, however, usually fractured by the agency of water and frost, so as to prevent their removal in an entire form. The colour of this mica is greenish, and it breaks into rhomboidal fragments.*

At the Wilks or Clove mine, in the vicinity of the preceding, plates of mica of a blackish green colour, and from one to five inches in length, are found associated with the magnetic iron ore.

Near Greenwood furnace, mica occurs in black or greenish black crystals, which are sometimes six or seven inches in diameter. It is associated with crystallized pyroxene, coccolite and calcareous spar. The most common form is an oblique rhombic prism. Fig. 389, *a* on *a′* usually about 120°; P on *a* 114° to 115°.

Fig. 389.



There is also a regular six-sided prism, the sides inclining to each other at an angle of 120°; but in these, as in the preceding, the inclination of the terminal to the lateral planes is about 114° or 115°, and 65° or 66°. Figs. 390, 391 and 392 represent sections of various forms

Fig. 390.

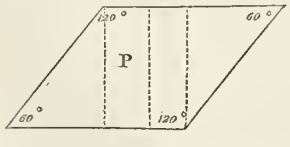


Fig. 391.

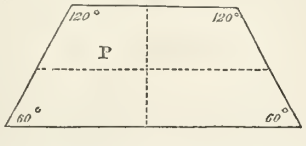
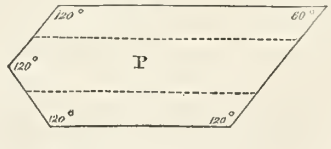


Fig. 392.



* The mica at this locality seems to be sufficiently abundant for profitable exploration.

Fig. 393.

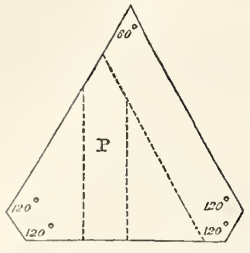
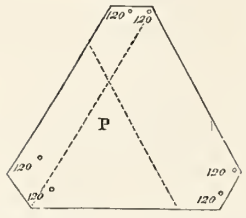


Fig. 394.



observed at this locality, with the direction of the cleavage. Figs. 393 and 394 represent compound crystals with five and six sides, two of them forming a reëntering angle. All these crystals are usually very perfect, and have their sides smooth and polished.

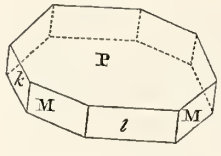
This mica has been analyzed by Prof. Von Kobell of Munich. The following are the results:*

Silica,	40.00
Alumina,	16.16
Oxide of iron,	7.50
Magnesia,	21.54
Potassa,	10.83
Oxide of titanium,	0.20
Fluoric acid,	0.53
Water,	3.00

According to Dr. Horton, the mica from this locality has long been used as a substitute for coloured glass, for spectacles. Almost any shade of colour can be obtained by using a larger or smaller number of plates.

Near West-Point, mica is of frequent occurrence in granite. It is sometimes black; at others, bronze-coloured. Occasionally it is met with in six-sided prisms.

Fig. 395.



Six miles southeast of the village of Warwick, in the town of the same name, black crystallized mica is found in a vein of feldspar in granite. It occurs in crystals and plates, which are sometimes a foot in diameter. Fig. 395 represents one of the forms observed. M on *l* 150°; M on *k* 120°.

Brown mica is found in white limestone near Edenville, while the silvery variety occurs near the village of Amity.

A mile northwest of Edenville it occurs in white limestone, in perfect hexagonal prisms with the angles 120°, and in rhombic prisms.

In the same vicinity, there are specimens of a silvery white colour, resembling mica, but rather more brittle than is usual with that mineral. It melts before the blowpipe into a white enamel, and agrees with the characters of *Lithion-mica*, as given by Dr. Turner. It seems to pass into talc.

Putnam County. Black mica, in rhomboidal and six-sided crystals, is found at Coldspring.

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* *Brewster's Edinburgh Journal of Science*. IX. 175.

At Hustis' farm, in Phillipstown, there are lead-coloured crystals, associated with serpentine in white limestone.

On the farm of T. Foster, in the town of Southeast, it occurs in small plates or flattened crystals of a green colour, associated with hornblende, serpentine and magnetic iron ore.

St. Lawrence County. Eight miles from Potsdam, on the road to Pierrepont, black mica has been found in plates of seven inches in length.

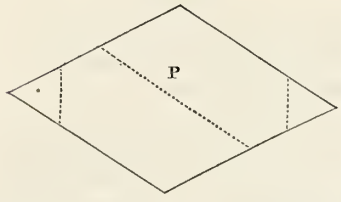
At Pope's mill on Fish creek in Morristown, mica has been obtained in six-sided crystals of a copper colour, sometimes six inches in diameter. The prisms are usually tapering, and sometimes have the plates bent or curved.

A mile southwest of the village of Gouverneur, silvery mica occurs in the white limestone. In the same town, the copper-coloured variety, in plates of considerable size, is often met with.

In the town of Rossie, two miles north of Somerville, there is a beautiful copper-coloured mica, associated with a buff serpentine in white limestone.

One of the finest localities is in the town of Edwards, where it occurs abundantly in crystals which are six-sided, or exhibit sections of this form. It is of a dark bronze-colour, transparent in thin laminæ. The sides incline to each other at angles of 119° and 121°. The laminæ are often much bent or twisted, and they are of various sizes from an inch to six inches in diameter. Fig. 396 is another form common at this locality.

Fig. 396.



There is also in the same town a beautiful silvery mica, which exhibits the same regular outline, and affords the finest specimens of this variety heretofore found in the State.

Saratoga County. In the town of Greenfield, about a mile north of Saratoga-Springs, handsome crystals and irregular plates of a reddish brown colour are found associated with feldspar, chrysoberyl, garnet and tourmaline in a vein of granite. This mineral has an uncommonly fine lustre; and the crystals, when viewed across the axis, have a rich oil-green colour.

The form represented in Fig. 388 has been observed at this locality. Many of the plates exhibit a beautiful star-like arrangement.

In some cases, small scales or crystals of mica are arranged in a plumose manner, and have the appearance of filaments of amianthus. This variety has been called *Prismatic mica.*

Washington County. Mica of a dark colour is found associated with pyroxene or hypersthene, on the banks of Lake George, about two miles south of Ticonderoga in the town of Putnam.

Westchester County. Mica is common in the gneiss rock in this county.

On the Croton aqueduct, near Yonkers, it is often crystallized in rhombs and in six-sided tables of a greyish brown colour, and having a beautiful lustre. It has a cleavage parallel to the shorter axis of the crystals, as in Fig. 390; and this is sometimes so marked, that very narrow plates or threads may be detached, resembling fibres of asbestus. At New-Rochelle,

similar crystals are found, but they do not exhibit this cleavage in so marked a manner. Black mica also occurs in small plates in the gneiss near Yonkers.

In the immediate vicinity of the village of Rye, specimens occur similar to those above described.

ORDER III. GLUCINA.

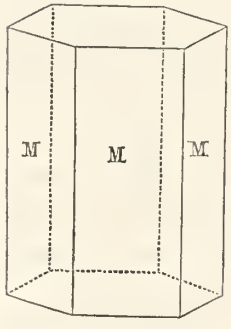
This includes two species:

1. Emerald. 2. Chrysoberyl.

EMERALD.

Emerald. *Cleaveland* and *Thomson.* — Emeraude. *Haüy* and *Beudant.* — Beryl and Emerald. *Phillips* and *Shepard.* — Rhombohedral Emerald. *Jameson.* — Rhomboedrischer Smaragd. *Mohs.*

Fig. 397.



Description. Colour green, blue, yellow and grey. Streak white. It occurs regularly crystallized, and in thin prismatic concretions. Primary form a regular six-sided prism, Fig. 397. Cleavage parallel to all the planes of the primary, but not distinct. Fracture conchoidal and uneven. Lustre vitreous. From transparent to translucent on the edges. Hardness from 7.5 to 8.0. Specific gravity 2.58 to 2.73. Before the blowpipe, the transparent varieties become clouded, and on increasing the heat, assume the appearance of mother of pearl; with borax, it fuses into a transparent colourless glass.

Varieties. *Emerald* and *Beryl* differ from each other chiefly in their colours. The former is transparent or translucent, and of an emerald green colour, which it derives from oxide of chrome; the latter, is either green, yellow, blue, grey, or entirely colourless. Between the two varieties there is a regular series, and hence no line of specific distinction can be drawn between them. The variety which is transparent, and has a sky-blue colour, is denominated by lapidaries *Aqua marine.*

Composition. *Emerald, from Peru*—Silica 68.50, alumina 15.75, glucina 12.50, lime 0.25, oxide of chromium 0.30, oxide of iron 1.00 (*Klaproth*).

Beryl, from Broddbo—Silica 68.35, alumina 17.60, glucina 13.13, oxide of iron 0.72, oxide of columbium 0.27 (*Berzelius*). This mineral is a silicate of alumina and glucina.

Geological Situation. This mineral, when in crystals, has heretofore been found in veins traversing granite. It also occurs in fractured crystals and rolled masses in secondary deposits. The most splendid crystals of emerald are found in a vein of magnesian limestone, which traverses a hornblende rock at Muso, near Santa Fé de Bogota, in Grenada.

LOCALITIES.

New-York County. Beryl is said to have been found near New-York, in small, pale green, semi-transparent crystals, in granite; and also in a similar deposit near Sing-Sing in Westchester county.*

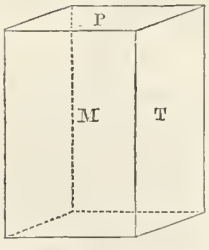
This mineral is as yet quite rare in this State, which is somewhat remarkable, as it is exceedingly abundant throughout New-England, especially in Massachusetts and Connecticut. At Acworth in New-Hampshire, crystals have been found weighing from two to three hundred pounds, and measuring four feet in length.

CHRYSOBERYL.

[From the Greek χρυσος, *gold*, and βηρυλλος, *beryl*; because it is a superior kind of beryl.]

Cymophane. *Haüy* and *Beudant.* — Chrysoberyl. *Cleaveland*, *Phillips*, *Thomson*, *Shepard* and *Dana.* — Prismatic Corundum. *Jameson.* — Prismatischer Korund. *Mohs.*

Fig. 398.



Description. Colour asparagus-green passing into greenish white, olive green and yellowish grey; it often exhibits a milk-white opalescence. Streak white. It occurs regularly crystallized, and in rolled fragments. The primary form is a right rectangular prism, Fig. 398. Cleavage parallel to the plane M, and with difficulty also parallel to the plane T, and to the longer diagonal of the prism. Fracture conchoidal. Lustre splendent and resino-vitreous. Transparent to translucent. Hardness 8.5. Specific gravity from 3.65 to 3.80. Infusible before the blowpipe alone; with borax, it fuses with difficulty into a transparent glass. It becomes electric by friction.

Composition. Silica 4.00, alumina 73.60, glucina 15.80, oxide of titanium 1.00, protoxide of iron 3.38, water 0.40 (*Seybert*).

Geological Situation. When in place, chrysoberyl is usually imbedded in granitic veins, and is associated with various other minerals peculiar to the primary rocks.

LOCALITY.

Saratoga County. The only locality of chrysoberyl at present known in this State, is in the town of Greenfield, about a mile north of the village of Saratoga-Springs. It occurs in a

* Pierce, Torrey and Maclure. *Cleaveland's Mineralogy.*

vein of granite traversing gneiss, and is associated with tourmaline, garnet, apatite, feldspar and mica. Its colour is usually yellowish green.

The crystals of chrysoberyl at this locality sometimes exhibit the primary form, and sometimes that represented in Fig. 399, which was first noticed by Dr. G. Troost,* the *anamorphique* of Haüy, in which the shorter terminal edges are replaced by the planes *i* : *i* on *i* 120°. Also Fig. 400, in which the lateral, as well as the shorter terminal edges are replaced by single planes. M on *s* 125° 16′; T on *s* 144°44′. Most commonly, however, the crystals are flat compound ones assuming a variety of forms, as represented in Figs. 401, 402, 403, 404, 405, 406, 407 and 408; the striæ being in most cases distinctly marked, as represented in the cuts. The manner in which these are produced will, I think, be understood by an inspection

Fig. 399.

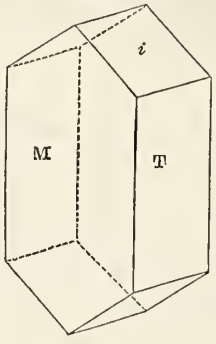


Fig. 400.

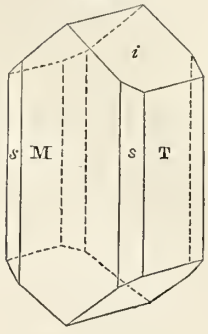


Fig. 401.

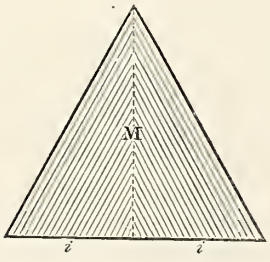


Fig. 402.

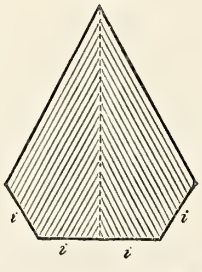


Fig. 403.

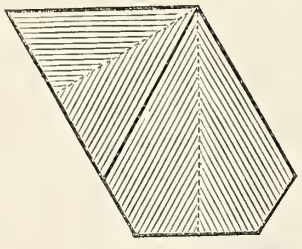


Fig. 404.

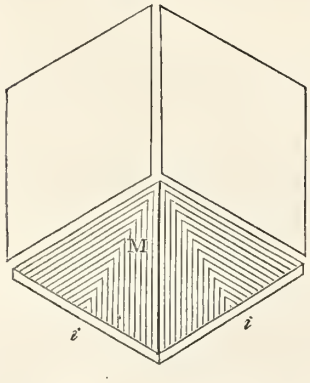


Fig. 405.

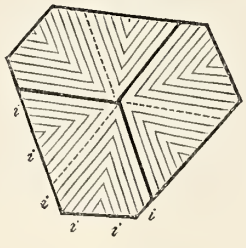


Fig. 406.

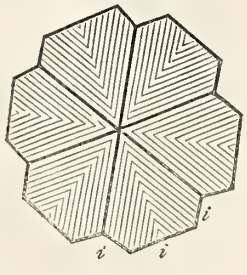


Fig. 407.

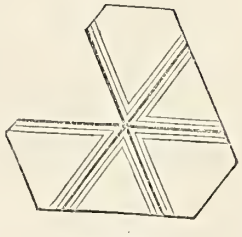
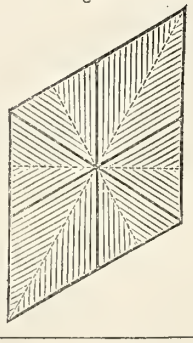


Fig. 408.



* *Journal of the Academy of Natural Sciences of Philadelphia.* III. 293.

Fig. 409.

Fig. 410.

Fig. 411.

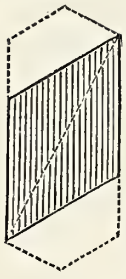
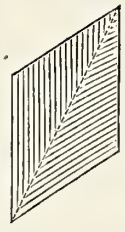


Fig. 412.



of Figs. 409, 410, 411 and 412. In Fig. 409, two opposite shorter terminal edges are replaced by the plane *i*. The striæ being perpendicular, and the axis of revolution being parallel to the edge formed by the meeting of the planes T and *i*, a revolution of 180° would give the form Fig. 401. Two of these crystals would give the right rhombic table represented in the lower part of Fig. 404; and again, three of these form the regular six-sided prism. The crystal 402 is in like manner formed by a similar revolution of a crystal like that represented in Fig. 410, in which all the shorter terminal edges are replaced by the planes *i*, being a crystal of the same form as Fig. 399. The two crystals Figs. 401 and 402 will produce the form Fig. 403, and three of the latter united give that of the six-sided prism Fig. 405. In Fig. 407, one of the crystals is wanting. Six of the forms Fig. 402 give that represented by Fig. 406, which is occasionally observed at this locality. The compound crystal Fig. 408 is marked by striæ as represented in the cut, and I suppose it to be produced by the union of four crystals similar to those represented in Fig. 401, and two formed by the revolution in the direction of the dotted line, Fig. 411, so as to give that represented in Fig. 412. The angles of all these crystals, whether single or compound, are 60° and 120°.

Fig. 413.

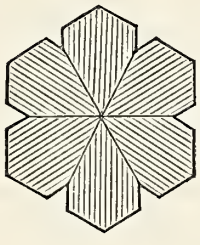


Fig. 413 is introduced from Shepard's Mineralogy. It is more rare at the Greenfield locality than either of the preceding. According to that author, in this case three prisms, similar to Fig. 410, cross each other, and the prisms project at each end beyond the face of composition. It will be observed that the direction of the striæ is different from that in the preceding figures, and I infer therefore that its composition is different.

In Connecticut, chrysoberyl occurs at Haddam, where it is associated with the minerals for which that locality is so celebrated.

ORDER IV. ZIRCONIA.

This order has only a single species, viz:

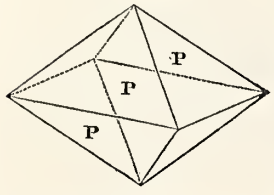
1. Zirconite, or Zircon.

ZIRCONITE.

Zircon. *Cleaveland, Phillips, Thomson, Beudant, Shepard* and *Dana.* — Pyramidal Zircon. *Jameson.* — Pyramidaler Zircon. *Mohs.*

Description. Colour grey and hyacinth-red; also white, green, brown, and rarely yellow, blue and red. It occurs regularly crystallized. Primary form an obtuse octahedron with a square base. Fig. 414. P on P over the base, 84° 20′; over a pyramidal edge, 123° 15′. According to some authors, the primary is a right square prism. In some varieties, the cleavage is very distinct. Fracture conchoidal. Lustre more or less adamantine. Ranges from transparent to opaque. Brittle. Rather easily frangible. Hardness 7.5. Specific gravity from 4.50 to 4.70. Before the blowpipe, if pure, it loses its colour, but retains its transparency, and does not fuse. It melts with borax into a transparent glass. It is not acted on by acids.

Fig. 414.



Varieties. Those varieties in which the cleavage is very distinct, and which have a hyacinth-red colour, are sometimes called *Hyacinth;* while those which are not thus characterized, are named *Common Zircon*, or *Zirconite.*

Composition. *Common Zircon.* — Zirconia 69.00, silica 26.50, oxide of iron 0.50 (*Klaproth*).

Hyacinth. — Zirconia 70.00, silica 25.00, oxide of iron 0.50 (*Klaproth*).

Zircon from Ceylon. — Zirconia 64.50, silica 32.00, oxide of iron 2.00 (*Vauquelin*).

Zircon from Expailly. — Zirconia 67.16, silica 33.48 (*Berzelius*). This mineral is a silicate of zirconia, and its formula is $Zr_2O_3SiO_3$.

Geological Situation. In this State, zircon has heretofore been found only in primitive rocks, either the granitic or limestone. I am not aware of its occurrence here in the trappean formations.

LOCALITIES.

Essex County. At Hall's iron mine in the town of Moriah, about eight miles west of the village of Port Henry, zircon has been found in a vein of white quartz, running through the ore. The crystals are of a cinnamon-red colour, sometimes translucent, and often with the

faces highly finished, but they are exceedingly brittle. The forms observed here, are the *prismé* of Haüy, Fig. 415, being the primary with the edges of the base truncated; the modification of the same, Fig. 416: the *plagièdre* of Haüy, Fig. 417; the *quadrisexdécimal* of Haüy, Fig. 418; together with those represented in Figs. 419, 420, 421, 422, 423 and 424.

Fig. 415. Fig. 416. Fig. 417. Fig. 418. Fig. 419.

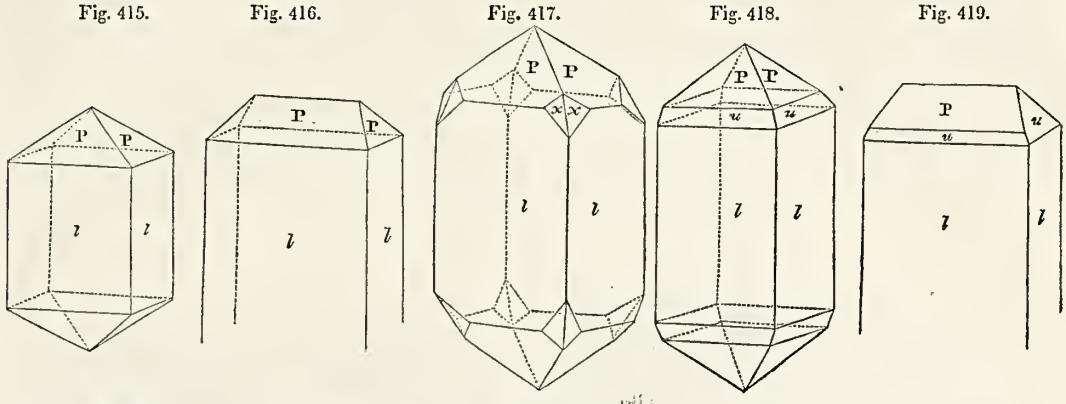
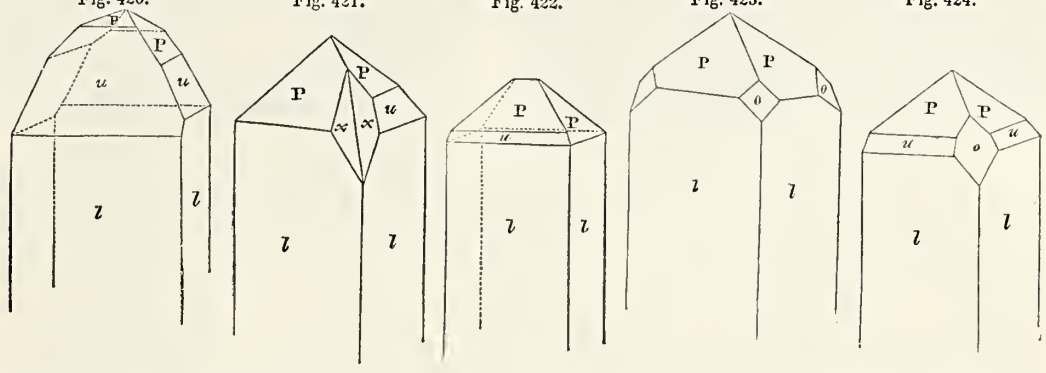
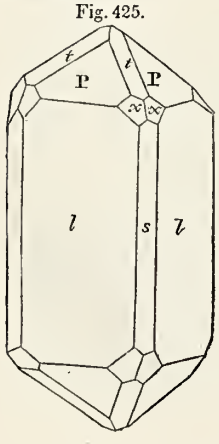


Fig. 420. Fig. 421. Fig. 422. Fig. 423. Fig. 424.



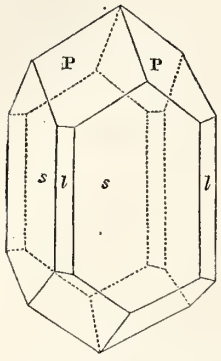
P on *l* 131° 49′; P on *u* 152° 8′; P on *x* 150° 5′; *l* on *l* 90°; *l* on *u* 159° 17′; *l* on *x* 142° 55′.

Fig. 425.



Orange County. Zircon is of frequent occurrence in the towns of Cornwall, Monroe and Warwick. In the Forest of Dean, in the town of Monroe, it is found in very minute crystals in scapolite, associated with pyroxene. Near the outlet of the Two ponds in the same town, it also occurs in scapolite, and associated with crystallized pyroxene and sphene. These crystals are sometimes more than an inch in length, and exhibit the forms represented in Figs. 415 and 417 as above, and in the accompanying Fig. 425, *binotriunitaire* of Haüy. P on *s* 117° 48′; P on *t* 152° 6′; P on *x* 150° 5′; *l* on *s* 135°; *l* on *x* 142° 55′. On Deer hill in the town of Cornwall, a mile southeast of the village of Canterbury, there is an abundant locality of zircon, which is accociated with magnetic iron ore, or the white quartz which

Fig. 426.

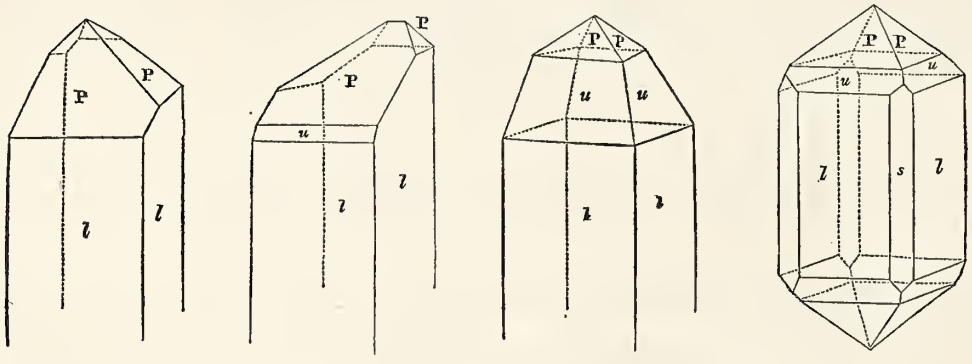


passes through it. The crystals of zircon are of a deep brownish red or black colour, some of which are translucent, and of a metallic or bronze lustre. Those in the quartz are often transparent. Some are very minute, while a few are an inch and a half in length. They are usually very brittle, and have imperfect or rounded terminations. The forms, Figs. 415, 417 and 426, *dioctaèdre* of Haüy, have been observed at this locality.

In the town of Warwick, at the southern base of Mount Eve, there occur small but perfect four-sided prisms with four-sided pyramids (Fig. 415). They are of a chocolate-brown colour, and are in an aggregate of limestone and scapolite.

Near Amity, there have been found crystals of a brown colour, with scapolite, reddish garnet, etc. On McGee's hill, Rocky hill, and on Warwick's mountain in the same town, zircon occurs of various colours, as white, reddish brown, reddish white, clove-brown and black. From this town have been obtained the crystals represented in Figs. 415, 417, 418, 422, 423, 424 and 426; also those here introduced, viz. Figs. 427, 428, 429 and 430. P on u 152° 8′; l on s 135°; l on u 159° 17′.

Fig. 427. Fig. 428. Fig. 429. Fig. 430.



Rockland County. In a granitic bowlder near Ladenton, perfect crystals of zircon have been found of a dark brown and black colour, with quite brilliant surfaces. The crystals are usually of the form represented in Fig. 417, but sometimes the planes x are greatly enlarged.

St. Lawrence County. Zircon probably will be found in various parts of this county. The finest locality at present known, is at Robinson's in the town of Hammond, near De Long's mills. It is associated with the magnificent crystals of apatite, and with feldspar, in white limestone. The zircon is of a reddish brown colour, in four-sided prisms, some of which are an inch and a half in length and half an inch wide, and are variously terminated. The forms represented in Figs. 416 and 422 have been found at this locality.

These crystals are sometimes of a lighter colour in the central part, and have a striped or

zoned appearance around the terminations. One of these being accidentally broken, I found a rounded mass of white carbonate of lime in the centre, occupying nearly the whole interior, while the faces were all perfect, and indeed quite highly finished. Whether this is in all cases the cause of the parti-coloured appearance of these crystals, I am unable to say, but it is more than probable that such is the case. The fact is curious, as showing that the presence of foreign bodies does not necessarily present any obstacle to the process of crystallization. Similar appearances are presented in the crystals from Johnsburgh. Some of these crystals also have been broken, and the terminations moved from their original situation, as shown in the figures given by Dr. Emmons in his report, and which he has obligingly permitted me to introduce. Fig. 431 exhibits the appearance of the broken crystals of zircon; Fig. 432 represents a bent crystal of apatite, associated with the zircon.

Fig. 431.

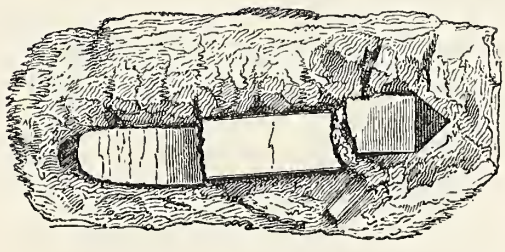
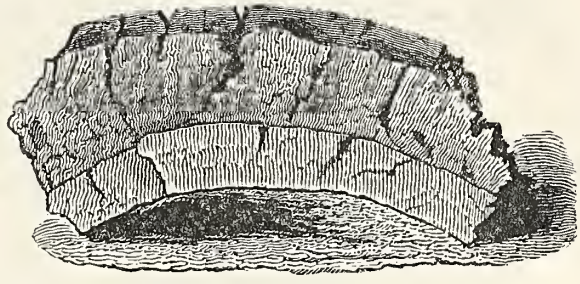


Fig. 432.



Warren County. The largest and most interesting crystals of zircon heretofore found in this State occur at Johnsburgh in this county. One of these is a modification of the *dioctaèdre* of Haüy, Fig. 433; and to this may be added the forms given in Figs. 434 and 435; and those represented in Figs. 415 and 418. The measurements have already been introduced, and need not be repeated.

Fig. 433.

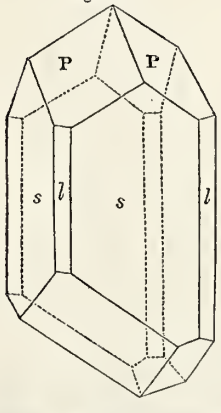


Fig. 434.

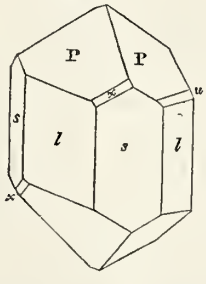
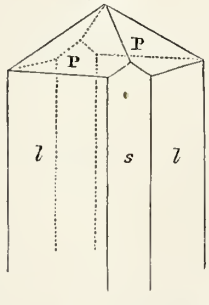


Fig. 435.



All the figures from the preceding locality have been drawn from specimens in the Cabinet of Dr. Emmons. The crystals were from half an inch to three-quarters of an inch in length, and from a quarter to half an inch in diameter, with all the planes perfect, and often very highly finished. They are of a reddish brown colour, with usually a lighter central portion as in the specimens from Hammond in St. Lawrence county, and are opaque or feebly translucent.

CLASS VII.

METALLIC MINERALS.

Composed either wholly, or in considerable proportion, of the Metals, commonly so called.

ORDER I. IRON.

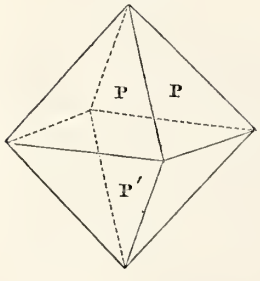
This includes several minerals, of which some are of great value.

1. Native Iron.
2. Magnetic Iron Ore.
3. Specular Iron Ore.
4. Limonite.
5. Iron Pyrites.
6. Magnetic Iron Pyrites.
7. White Iron Pyrites.
8. Arsenical Iron Pyrites.
9. Scorodite.
10. White Iron Sinter.
11. Spathose Iron.
12. Ankerite.
13. Copperas.
14. Alumina-Sulphate of Iron.
15. Chrome-Iron Ore.
16. Vivianite.
17. Cacoxenite.
18. Ilvaite.
19. Silicate of Iron.
20. Hudsonite.

NATIVE IRON.

Fer Natif. *Haüy.* — Native Iron. *Cleaveland, Phillips* and *Thomson.* — Octahedral Iron. *Jameson.* — Octaedrisches Eisen. *Mohs.*

Fig. 436.



Description. Colour pale steel-grey. It occurs regularly crystallized and also massive. The primary form is the regular octahedron, Fig. 436. Cleavage parallel with the primary (*Shepard*). Fracture hackly. Lustre metallic. Opaque. Hardness 4.5. Specific gravity from 7.318 to 7.80.

Composition. *Specimen from Canaan, Connecticut*—Iron 91.80, carbon 7.00 (*Shepard*).

From Ramsdorf—Iron 92.50, lead 6.00, copper 1.50 (*Klaproth*).

This metal, which is exceedingly rare in its native state, has heretofore been chiefly found in those meteoric stones which have fallen at various times in different parts of the world.

Under these circumstances, the specimen almost always contains a small proportion of nickel or chromium. In a few cases, however, native iron of undoubted terrestrial origin has been found. Such are the varieties from Canaan, Connecticut, and from Guilford in North Carolina; the latter of which consists of a single octahedral crystal, now in the Cabinet of Yale College, weighing seven ounces, and which is said to have been detached from a mass weighing twenty-eight pounds.*

LOCALITIES.

Otsego County. In the cabinet of the Albany Institute, there is a specimen labelled "Native Iron from Burlington," in this county. It was received from Prof. J. Hadley, but I know nothing further of its history. It is malleable, and has a blackish coating.

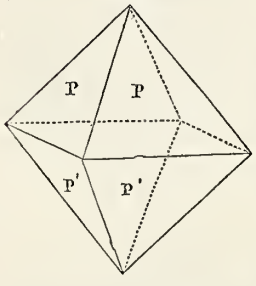
Yates County. Mr. T. G. Clemson has described a specimen of what he called native iron, found near Penn-Yan. It was represented as being from a larger mass found in a sandstone rock. It acted on the needle, was free from oxides, and contained a minute portion of carbon, but neither nickel nor cobalt could be detected in it.†

MAGNETIC IRON ORE.

[In allusion to its magnetic properties.]

Fer Oxidulé. *Haüy.* — Magnetic Oxide of Iron. *Cleaveland.* — Octahedral Iron Ore, Black or Magnetic Iron Ore. *Jameson.* — Magnetic Iron Ore, *Thomson* and *Dana.* — Octaedrisches Eisen-Erz. *Mohs.* — Oxidulated Iron. *Phillips.* — Aimant. *Beudant.* — Magnetic Iron. *Shepard.*

Fig. 437.



Description. Colour usually iron-black, but sometimes bluish or steel-grey. Streak always nearly or quite black. It occurs regularly crystallized; also in grains, massive and disseminated. The primary form is a regular octahedron, Fig. 437. Cleavage parallel with the primary. Fracture uneven or conchoidal. Lustre metallic. Opaque. Brittle. Hardness from 5.5 to 6.5. Specific gravity from 4.74 to 5.20. It is attracted by the magnet, and sometimes exhibits polarity. Infusible by the blowpipe alone, but becomes brown, and loses its magnetism. With borax, in the oxidizing flame it fuses into a dull red glass, which becomes clear on cooling, and often assumes a yellow tint; in the reducing flame, it becomes bottle-green. Insoluble in nitric acid, but usually soluble in hot concentrated muriatic acid. Sometimes, however, it is necessary to calcine the ore with carbonate of potash or soda, before its solution can be effected. The black colour of its powder, and its strong action upon the magnet, will usually serve to distinguish this species from the specular iron ore which it often resembles.

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* Shepard. *Treatise on Mineralogy.* II. 70.

† *Transactions of the Geological Society of Pennsylvania.* I. 358.

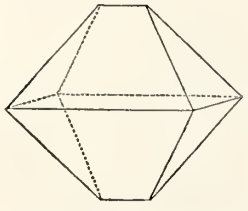
Composition. It consists entirely of iron and oxygen, in the proportion of two atoms of peroxide to one atom of protoxide, and contains 28.21 of oxygen and 71.79 of metallic iron. But these proportions are liable to variation. The true formula is probably $FeO+Fe_2O_3$.*

Geological Situation. This mineral, which occurs in beds, veins and masses of vast extent, is found only in the older formations, as granite, gneiss and mica slate. It has also been found in the transition and secondary trap rocks, but we have as yet no instances of the kind in this State.

LOCALITIES.

In the former part of this work (p. 5), I have given a full account of our localities of magnetic iron ore, with the modes of reduction practised in various parts of the State (p. 38). I shall therefore here only introduce a few notices which may be interesting in a strictly mineralogical point of view.

Fig. 438.



The finest crystal of the magnetic oxide of iron which I have seen from this State, is in the cabinet of the Albany Institute, and was presented to it many years since by Teunis Van Veehten, Esq. of Albany. It is said to have been found in Essex county. The form is a cuneiform octahedron, similar to Fig. 438, but with some of the edges truncated. It is an inch and a half in length, and is strongly magnetic, but feebly polar.

O'Neil mine in the county of Orange, has been long known as one of the most interesting localities of the crystallized variety of the magnetic iron ore. In the fissures of the massive variety, crystals of small size, but very perfect, have been found in abundance. They are black and shining, but often have a beautiful irideseence. The most common forms are the regular octahedron, Fig. 437; the octahedron with one or more of the solid angles replaced by tangent planes, as in Figs. 439 and 440. These replacements are, in a few cases, carried so far as to give rise to the form Fig. 441, and even the cube 442; but the latter is very rare

Fig. 439.

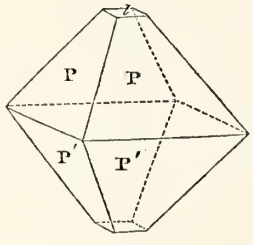


Fig. 440.

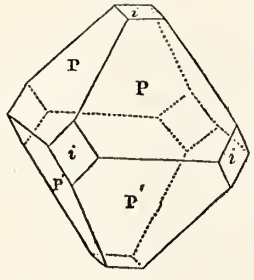


Fig. 441.

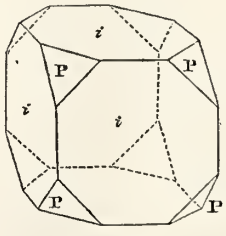
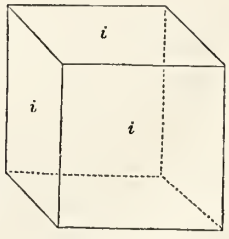


Fig. 442.



* There is still a difference of opinion, however, in regard to the true chemical formula of this ore.

Fig. 443.

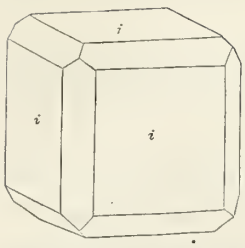
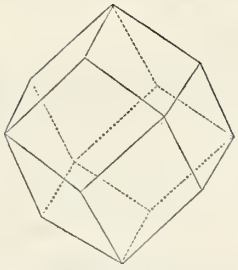


Fig. 444.



at this locality. According to Dr. Horton, the cube with the edges truncated, Fig. 443, has also been found here.

Octahedrons of the same species also occur at Amity in this county, and a few dodecahedrons have been observed at a locality six miles south of Warwick. Fig. 444.

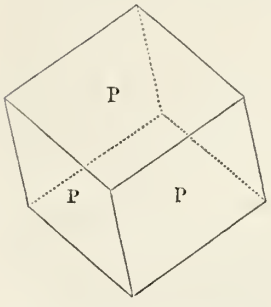
The specimens from the Rich iron mine are remarkable for the ease with which they cleave in the direction of the primary octahedron. This cleavage is exhibited, though in a much less distinct manner, in specimens from several of our other localities.

SPECULAR IRON ORE.

[From the Latin *speculum*, *a mirror;* on account of its brilliancy.]

Fer Oligiste. *Haüy.* — Specular Oxide of Iron. *Cleaveland.* — Specular Iron Ore. *Thomson.* — Specular Iron. *Phillips*, *Dana* and *Shepard.* — Oligiste. *Beudant.* — Rhombohedral Iron Ore. *Jameson.* — Rhomboedrisches Eisen-Erz. *Mohs.*

Fig. 445.



Description. Colour dark steel-grey bordering on iron-black, iron-black and brownish red. Streak red or reddish brown. It occurs regularly crystallized; and also massive, disseminated, reniform, botryoidal, stalactitic and globular. Primary form a rhombohedron. Fig. 445. P on P 86° 10′, and 93° 50′. Fracture conchoidal or earthy. Lustre metallic or semi-metallic. From transparent to opaque. Hardness from 5.5 to 6.5. Specific gravity from 4.80 to 5.30. Sometimes feebly magnetic. Infusible by the blowpipe alone; with borax, it melts into a green or yellow glass, like the magnetic oxide. It is usually soluble in hot muriatic acid.

The red powder of this mineral, and its feeble action on the needle, will in general be sufficient to distinguish it from the preceding species.

Varieties. The most strongly characterized varieties are the *Specular Iron Ore*, or *Iron Glance*, which includes those which have a black colour and are more or less regularly crystallized; the *Red Iron Ore* and the *Red Hematite*, which have a red colour, the latter being fibrous.

Composition. When pure, the specular iron ore is a pure peroxide of iron, containing 69.34 of iron, and 30.66 of oxygen. But it almost always contains foreign matters, either earthy or saline. Formula Fe_2O_3.

Geological Situation. Specular iron ore occurs in beds or veins in the primary or lower transition rocks. It has not been found in extensive deposits in the secondary ones.

LOCALITIES.

As in the preceding species, I must refer the reader for a full account of the New-York localities of the specular iron ore, to the first part of this work (p. 23). I here add only a few notices of a purely mineralogical character.

Fig. 446.

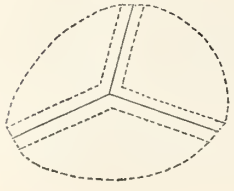
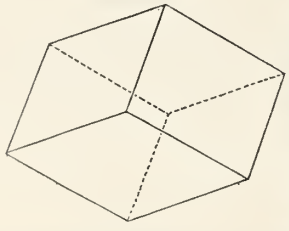


Fig. 447.



In the county of St. Lawrence, this mineral is often found in the form of crystalline plates, the edges of which are rounded as in Fig. 446, being modifications of very obtuse rhombohedra, Fig. 447, and quite similar to the *lenticular* crystals of calcareous spar (see Fig. 70). Sometimes these crystals are nearly flat, and have a hexagonal outline. Perfect forms are very rare. The semi-crystallized varieties are usually associated with the dodecahedral crystals of quartz.

LIMONITE.

Limonite. *Beudant* and *Shepard.* — Hydrous Peroxide of Iron. *Thomson.* — Brown Oxide of Iron, and Argillaceous Oxide of Iron. *Cleaveland.* — Prismatic Iron Ore. *Jameson.* — Hydrous Oxide of Iron, and Brown Hematite. *Phillips.* — Brown Iron Ore. *Dana.* — Prismatisches Habronem-Erz, and Prismatoidisches Habronem-Erz. *Mohs.**

Description. Colour various shades of brown, sometimes yellowish. Streak yellowish brown. Without action on the magnet. It very rarely occurs crystallized, but it usually presents stalactitic, botryoidal or mammillary forms having a fibrous structure; it is also massive and earthy. The primary form said to be a right rectangular prism, (*Phillips*); a right rhombic prism, (*Mohs*); a cube? (*Beudant*). Fracture uneven, even, conchoidal, or earthy. Lustre more or less adamantine. Opaque or translucent on the edges; crystals said to be sometimes semi-transparent, and showing a blood-red colour. Hardness from 5.0 to 5.5. Specific gravity from 3.37 to 3.94. Infusible by the blowpipe, but gives out water by calcination, and most of the varieties become black or reddish black and magnetic; with borax, it melts into a green or yellow glass. Soluble in heated nitro-muriatic acid.

Composition. Peroxide of iron 82.00 to 84.00, water 11.00 to 14.00, oxide of manganese 2.00, silica 1.00 to 2.00. It is therefore a hydrous peroxide of iron, and contains, when pure, peroxide of iron 85.30, and water 14.70. Formula Fe_2O_3+Aq.

* In the first part (page 29), *Limonite* is incorrectly referred to the *Rhombohedral Iron Ore* of Jameson and Mohs.

Geological Situation. It occurs in masses, veins and beds often of great extent, in primitive, transition and secondary rocks.

LOCALITIES.

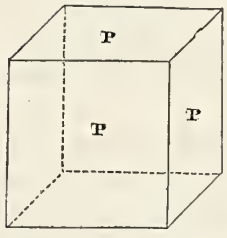
In regard to the localities of this ore in the State of New-York, I have nothing to add to the notice presented in the first part of this work (page 29 et seq.)

IRON PYRITES.

[From the Greek πυρ, *fire;* because it gives fire when struck with steel.]

Fer Sulfuré. *Haüy.* — Sulphuret of Iron. *Cleaveland.* — Iron Pyrites. *Phillips* and *Shepard.* — Bisulphuret of Iron. *Thomson.* — Hexahedral Iron Pyrites. *Jameson.* — Hexaedrischer Eisen Kies. *Mohs.* — Pyrite. *Beudant.*

Fig. 448.



Description. Colour bronze yellow, rarely inclining to steel-grey; sometimes brown, owing to decomposition. Streak brownish or greenish black. It occurs regularly crystallized; also massive, disseminated, globular and cellular. Cleavage parallel with the cube and octahedron, but most perfect with the former, which has hence been adopted as the primary, Fig. 448. Fracture uneven and conchoidal. Lustre metallic. Opaque. Brittle. Hardness from 6.0 to 6.5. Specific gravity from 4.83 to 5.05. Before the blowpipe, it exhales a strong odour of sulphur, and yields a brownish globule, obedient to the magnet; and by continuing the heat, it is converted into an uneven and crystalline black mass.

It is much less hard than copper pyrites, which it sometimes resembles. From magnetic pyrites, it is distinguished by its want of action on the magnet. Some varieties are subject to spontaneous decomposition.

Composition. Iron 47.85, sulphur 52.15 (*Hatchett*). Iron 45.15, sulphur 54.26 (*Berzelius*).

There can be no doubt, therefore, that this is a compound of two atoms of sulphur and one atom of iron. Its proper chemical name, therefore, is *Bisulphuret of Iron*, and its formula is FeS_2.

Geological Situation. This mineral is found in almost all the different series of rocks.

Uses. Iron pyrites is used in the manufacture of copperas, and of sulphuric acid.

LOCALITIES.

Columbia County. The roof slate found at Hillsdale, contains abundance of cubic crystals of iron pyrites. These crystals undergo decomposition, and leave cavities in the slate. Mr. Mather remarks that this mineral, thus liable to decomposition, injures the slate, not only by causing cavities through which leakage takes place, but by changing its texture.

Erie County. This mineral is very abundant on the slate near Eighteen-mile creek, on the shore of Lake Erie. There are also thousands of pyritized petrifactions near Buffalo.

Essex County. In almost all the mines of magnetic iron ore, iron pyrites occurs either in small grains or larger masses. It is also sometimes observed in the white limestone. In the vicinity of Port Henry, crystals are occasionally found of the primary form (Fig. 448), and of the octahedron with the solid angles replaced by rectangular planes, Fig. 449; and also the dodecahedron with pentagonal faces, *dodécaèdre* of Haüy, Fig. 450. P on *d* 152° 15′ 52″; *e* on *e* 126° 52′ 12″; *e* on *e′* or *e″* 113° 34′ 41″ (*Haüy*).

Fig. 449.

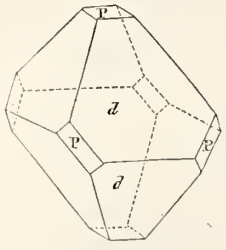
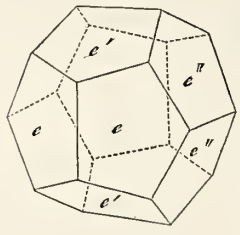


Fig. 450.



Franklin County. About half a mile from the residence of James Duane, Esq., near the road leading to Malone, there is an extensive bed of iron pyrites. On exposure to the air, the entire rock is decomposed, and crumbles to the ground in the form of a green sulphate of iron or copperas. There is a small stream in the vicinity, and it is thought that copperas may be advantageously manufactured.*

Fig. 451.

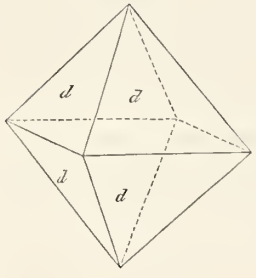
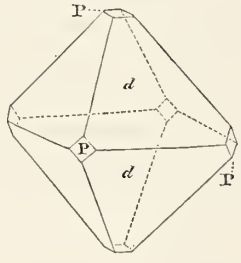


Fig. 452.



Jefferson County. In the town of Champion, this mineral occurs radiated, plumose, and in crystals of a white and pale yellow colour. The crystals are in the form of the octahedron. Fig. 451. *d* on *d*, over the base, 109° 28′ 16″.

Crystals similar to Fig. 452, are occasionally found with the preceding, on the banks of Vrooman lake, near the village of Oxbow. They are of a dark colour externally. P on *d* 152° 15′ 52″.

Lewis County. About a mile and a half northeast of Natural bridge, iron pyrites occurs abundantly in well defined cubes, in a kind of trappean rock. It occurs also massive, and is of a bright bronze yellow colour.

Near Martinsburgh, it is associated with calcareous spar, in the veins of galena which there traverse the limestone. The crystallized variety sometimes assumes the form of the cuneiform octahedron. The regular octahedron (Fig. 451) has also been observed at this locality.

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* See a communication of B. S. Roberts, in the Report of the Commissioners to survey the Ogdensburgh and Champlain railroad. *Documents of the New-York Legislature*, 1841.

At Lowville, this mineral is associated with the green fluor; and as it is subject to decomposition, the specimens soon crumble and lose their beauty. This difficulty can be prevented by immersing them in a solution of gum arabic, or in copal varnish.

Montgomery County. This mineral, in the massive form, is found associated with galena, on Flat creek in the town of Root, two miles southeast of Spraker's basin.

New-York County. Iron pyrites, in exceedingly small cubic crystals, occurs throughout the island in the gneiss, and in the limestone at Kingsbridge. It is also occasionally found in the limestone, in small dodecahedrons with pentagonal faces (Fig. 450).

Oneida County. It is thickly disseminated in grains and small crystals in the millstone grit near Utica.

Orange County. This mineral occurs in the form of cubes, two miles southeast of the village of Warwick; at Carpenter's point; and four miles north of Newburgh. The massive variety is of frequent occurrence, and is usually associated with the magnetic iron ore. The specimens found two miles southeast of Warwick have a yellow colour, and are both massive and crystallized in cubes, which sometimes have bent or curved faces They contain oxide of titanium, mica, zircon, fluor and feldspar, and gold in small quantity is said to have been found in them.

Fig. 453.

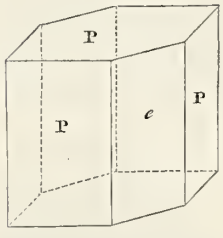
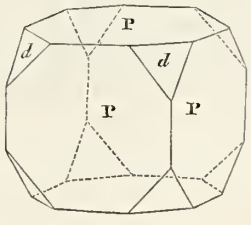


Fig. 454.



In the town of Deerpark, crystals occur in the form of the cube, with two opposite edges deeply replaced by tangent planes, Fig. 453; and the cube with all the solid angles replaced by tangent planes, *cubo-octaèdre* of Haüy, Fig. 454.

Putnam County. A few localities have been noticed in this county, where Mr. Mather thinks it probable that iron pyrites may be economically employed. Thus in one part of the Phillips ore bed, near the summit of the mountain, the magnetic iron ore is so much intermixed with iron pyrites, that it cannot be used in the furnace. In some places the pyrites seems to have been the paste in which the grains of iron ore are disseminated, but in general it is not so abundant: one-half to one-sixth of the ore may be said to be pyrites. By exposure to the weather, sulphate of iron or copperas is formed; and it might be made artificially from the ore in large quantities, if other parts of the bed yield it as abundantly as that above noticed.*

The same mineral is found in some abundance in the valley of Patterson; on Wood's farm, six miles south-southeast of the village of Carmel; and a quarter of a mile east of Ludding-ton's mills.

Richmond County. Crystals of iron pyrites of a rich yellow colour, occur in the fissures of lignite near Rossville. They are often of great beauty, but decompose rapidly upon

* Mather. *New-York Geological Reports*, 1839.

exposure to the atmosphere. The hepatic variety is mentioned by Cleaveland as having been found in this county.

St. Lawrence County. There are several localities in this county, where iron pyrites occurs both massive and crystallized. In the vicinity of Canton, there are extensive beds which may be advantageously employed in the manufacture of copperas.

The *hepatic* variety of this mineral has been found in the vicinity of Pope's mill, associated with crystallized mica. It has a bronze-yellow colour, which tarnishes by exposure; has a lamellar structure, and the laminæ are easily separable. It is not magnetic. In its chemical characters, it agrees with the other varieties.

The crystallized mineral is often associated with galena, numerous veins of which are known to occur in various parts of this county. The most interesting specimens have heretofore been found at the Rossie vein. The colours are bronze and pinchbeck-yellow, sometimes yellowish white. The lustre and finish of the crystals are frequently very high, and their perfection does not appear to be impaired by exposure. Among the forms which have been noticed here, are the cube (Fig. 448); the cube with the edges replaced by tangent planes, sometimes so slightly as to be scarcely perceptible, Fig. 455; the cube with the angles and edges all replaced by planes, as in Figs. 454, 456, 457 and 458; together with the *triglyphe* of Haüy,

Fig. 455.

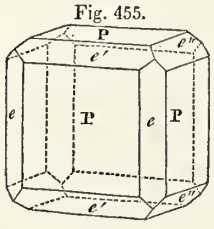


Fig. 456.

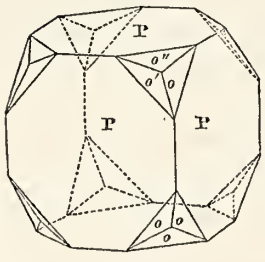


Fig. 457.

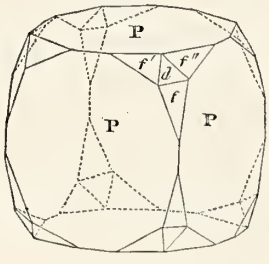


Fig. 458.

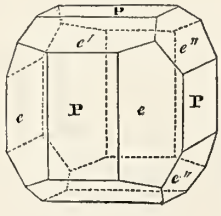


Fig. 459.

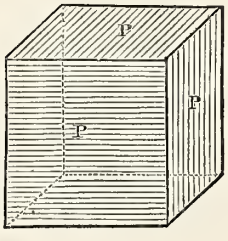
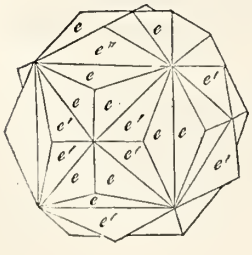


Fig. 459, in which the threefold cleavage is distinctly indicated by the striæ. P on *o* 144° 44′ 8″; *o* on *o′* or *o″* 146° 26′ 33″; P on *f* or *f′* 143° 18′ 2″; P on *d* 152° 15′ 52″; *d* on *f* 157° 47′ 33″ (*Haüy*).

Fig. 460.



Schoharie County. About a mile west of Schoharie court-house, iron pyrites occurs in great abundance in single crystals and groups, in a decomposed clayey green shale. The colour is from brass yellow to reddish brown. Small but very perfect cubes are found in a kind of dark-coloured cellular heavy spar. In the slate, the crystals generally have the form of the *dodécaèdre* of Haüy (Fig. 450). They are sometimes from half to three-quarters of an inch in diameter. The forms represented in Fig. 455, 458 and 459, and the compound one, Fig. 460, also occur at this locality.

The above crystals often have a high lustre, and do not suffer any change by exposure to the atmosphere.

This is undoubtedly one of the most remarkable deposits of iron pyrites in the United States, whether we consider the abundance of the specimens, or the perfection and interest of the crystalline forms.

Suffolk County. This mineral occurs in several places, associated with lignite, as in Richmond county. According to Mr. Mather, it is most abundant at the clay pits on West neck and Little neck near Huntington.

Sullivan County. Cubic crystals, of a brass yellow colour, are found associated with galena, zinc blende and copper pyrites at the mine two miles northeast of the village of Wurtzborough. The crystals sometimes exhibit the form of the *cubo-dodécaèdre* (Fig. 458).

Warren County. Johnsburgh and Chester furnish some highly modified forms of iron pyrites. At the latter locality, it is often accompanied by tourmaline and rutile. The crystals from Johnsburgh have a pale yellow and bronze colour, and a finish equal to any found in the State. The forms are the dodecahedron with pentagonal faces (Fig. 450); and also those represented in Figs. 461 and 462. *d* on *e* 140° 46′ 7″; *e* on *e* 126° 52′ 12″; *e* on *e′* or *e″* 113° 34′ 41″; P on *d* 125° 15′ 52″; P on *e* 153° 26′ 5″ (*Haüy*).

Fig. 461.

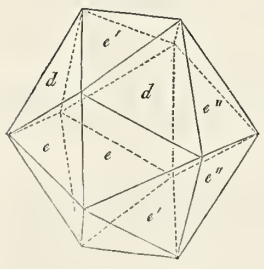
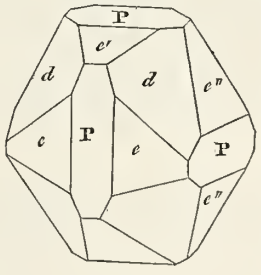


Fig. 462.



Westchester County. Iron pyrites, having the cubical form, and of great brilliancy, is found in thin veins of calcareous spar in gneiss, on the Croton aqueduct near Yonkers. The gneiss usually gives out a very fetid odour, which is probably to be ascribed to its being impregnated with minute particles of this mineral.

It also occurs in small dodecahedral crystals, similar to those at Kingsbridge, in the white limestone at Sing-Sing. And the hepatic variety is said to have been found in large quantities at Anthony's Nose, mingled with common pyrites and phosphate of lime.*

Ulster County. Small dodecahedral crystals of iron pyrites (Fig. 450), occur in a kind of water limestone at High falls in the town of Marbletown. They exactly resemble those from Schoharie. According to Mr. Mather, these crystals are contained in a slaty limestone underlying the cement rock.†

There is a fine locality of crystallized iron pyrites in Shoreham in Vermont, where it occurs in the dark coloured limestone.

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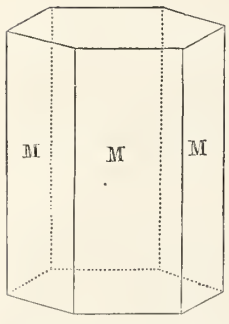
* Pierce and Torrey. *Cleaveland's Mineralogy.*

† *New-York Geological Reports*, 1840.

MAGNETIC IRON PYRITES.

Fer Sulfuré Ferrifère. *Haüy.* — Magnetic Sulphuret of Iron. *Cleaveland.* — Magnetic Iron Pyrites. *Phillips* and *Shepard.* — Magnetic Pyrites. *Thomson.* — Rhombohedral Iron Pyrites. *Jameson.* — Rhomboedrischer Eisen-Kies. *Mohs.* — Leberkise. *Beudant.*

Fig. 463.



Description. Colour intermediate between bronze-yellow and copper-red; speedily tarnishes on exposure to the air. Streak dark greyish black. It rarely occurs crystallized; usually massive and disseminated. Primary a regular six-sided prism, Fig. 463. Cleavage parallel with the terminal planes; less distinct parallel with the lateral ones. Fracture uneven, passing into conchoidal. Lustre metallic. Opaque. Brittle. Hardness 3.5 to 4.5. Specific gravity 4.63. It acts slightly upon the magnetic needle. Before the blowpipe, sulphur is evolved, and it melts into a blackish globule which is obedient to the magnet. It is almost entirely soluble in muriatic acid, with the evolution of sulphuretted hydrogen gas.

This mineral differs from common iron pyrites in its peculiar colour, its liability to tarnish, and in its being slightly magnetic.

Composition. Iron 63.50, sulphur 36.50 (*Hatchett*). Iron 60.32, sulphur 38.78 (*Rose*). Iron 59.85, sulphur 40.15 (*Stromeyer*).

Haüy supposed that this mineral is a common sulphuret of iron, mixed with a little metallic iron. The proportion of the latter, however, must be quite variable, and its true atomic composition has not been accurately determined. It is probably $FeS+Fe_2S_3$.

Geological Situation. Magnetic pyrites is usually associated with magnetic iron ore in rocks of the primary series, especially granite and gneiss. It has not been met with in much abundance in this State.

Uses. This mineral is, like the preceding, employed in the manufacture of copperas and sulphuric acid.

LOCALITIES.

Essex County. Masses of magnetic iron pyrites of some size have been found about a mile and a half north of Port Henry, on the land of Mr. A. Stone. It has the peculiar tarnish of that mineral, is strongly attracted by the magnet, and possesses polarity in a high degree. It may be mixed with a small proportion of magnetic iron ore.

Lewis County. Near Natural bridge in the town of Diana, small masses are found in an aggregate of mica, quartz and carbonate of lime.

Orange County. This mineral occurs, usually associated with the magnetic iron ore, at the O'Neil mine, the Rich iron mine, near Greenwood furnace, and in other parts of the town of Monroe. The specimens are massive, and usually have a pale yellowish colour. Small fragments are attracted by the magnet, but not so powerfully as the specimens from Essex county, nor do any of them possess polarity.

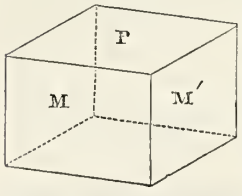
In Connecticut, the crystallized variety of magnetic iron pyrites occurs at Monroe and in Trumbull.

WHITE IRON PYRITES.

Radiated Sulphuret of Iron, a variety of Iron Pyrites. *Cleaveland.* — Fer Sulfuré Blanc. *Haüy.* — White Iron Pyrites. *Phillips* and *Shepard.* — Radiated Pyrites. *Thomson.* — Prismatic Iron Pyrites. *Jameson.* — Prismatischer Eisen Kies. *Mohs.* — Sperkise. *Beudant.*

Description. Colour pale bronze-yellow, sometimes inclining to steel-grey or brass-yellow. Streak greyish black or brownish black. It occurs regularly crystallized; also stalactitic, reniform and botryoidal. Primary form a right rhombic prism. Fig. 464. M on M′ 106° 2′. Cleavage parallel with M, rather perfect. Fracture uneven. Lustre metallic. Opaque. Brittle. Easily frangible. Hardness from 6.0 to 6.5. Specific gravity from 4.67 to 4.85. Before the blowpipe, the sulphur is driven off, and oxide of iron remains. It is sometimes particularly liable to decomposition. The difference in the crystalline form, however, is a more sure mark of distinction. It is only slightly acted on by muriatic acid.

Fig. 464.



Varieties. When this mineral occurs in radiated concretions, it is called *Radiated Pyrites;* when it is found in spear-shaped twin or triple crystals, it is named *Spear Pyrites;* and when the crystals are aggregated so as to have the form of the crest or comb of a cock, it forms the *Cockscomb Pyrites.*

Composition. Iron 45.66, sulphur 54.34 (*Hatchett*). Iron 45.07, manganese 0.70, sulphur 53.35, silica 0.80 (*Berzelius*). The constituents are therefore the same as that of the preceding, and it differs from it only in its specific gravity and crystalline form.

Geological Situation. This mineral is found in rocks similar to those which contain the last mentioned species.

LOCALITIES.

Orange County. The crystallized variety occurs two and a half miles southeast of the village of Warwick, in a vein of feldspar in granite, associated with zircon and tourmaline. The crystals are sometimes an inch in length, of a white and pale bronze-yellow colour, and striated longitudinally. They are less hard than those of common iron pyrites, and decompose easily. Before the blowpipe, they give out the odour of sulphur, and melt into a globule which is black and magnetic when cold. Crystals of the form represented in Fig. 465 have been found here, and also the compound one made up of five individuals, Fig. 466. M on M′ 106° 2′; P on *c* 160° 48′; *a* on *c* 141° 30′.

Fig. 465.

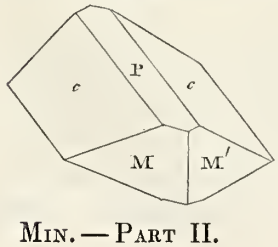
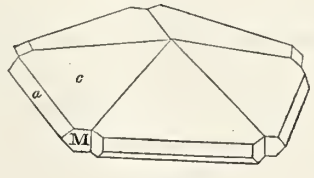


Fig. 466.



Putnam County. I also refer to this species the crystals which are sometimes met with in the magnesian limestone of Hustis' farm in Phillipstown. These crystals are sometimes half an inch in length by an eighth of an inch in diameter, and have the form of right rhombic prisms. They are of a pale yellow colour, and are usually very easily decomposed, being converted into a red oxide of iron, still retaining the crystalline form of the original mineral.

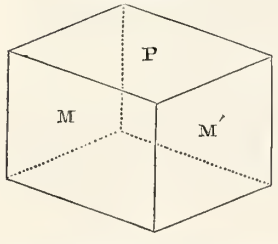
It is quite probable that many varieties now referred to common iron pyrites, will hereafter be found to belong to this species. In the absence of crystalline forms, it is almost impossible to decide.

The massive and fibrous varieties of white iron pyrites are found abundantly in various parts of Massachusetts and Connecticut.

ARSENICAL IRON PYRITES.

Fer Arsenical. *Haüy.* — Arsenical Iron. *Cleaveland* and *Phillips.* — Arsenical Pyrites. *Thomson* — Mispickel. *Beudant* and *Shepard.* — Prismatic Arsenic Pyrites. *Jameson.* — Prismatischer Arsenic Kies. *Mohs.*

Fig. 467.



Description. Colour silver-white, inclining to and passing into steel-grey. Streak greyish black. It occurs regularly crystallized; also massive and disseminated. Primary form a right rhombic prism. Fig. 467. M on M′ 111° 18′. Cleavage parallel with M and M′, pretty distinct; traces parallel with P. Fracture uneven. Lustre metallic. Opaque. Brittle. Hardness from 5.5 to 6.0. Specific gravityform 5.70 to 6.20. Before the blowpipe, in a bulb tube, it gives a sublimate of metallic arsenic, and then fuses to a black bead, which, after a long continuance of the blast, becomes magnetic (*Von Kobell*). Soluble in nitric acid, with the separation of sulphur and arsenious acid. The solution gives an abundant blue precipitate with ferrocyanate of potassa.

Composition. Iron 36.04, arsenic 42.88, sulphur 21.08 (*Stromeyer*). According to Beudant, the formula is FeS_2+FeAs_2.

Geological Situation. In this State, arsenical iron pyrites has been found only in the primary rocks.

LOCALITIES.

Essex County. The massive variety, of a tin-white colour, is found in a narrow vein, associated with hornblende and other minerals, in the town of Lewis, about ten miles south of Keeseville.

Orange County. Arsenical iron pyrites is found in various parts of this county. Perhaps the most interesting locality is that on Hopkins' farm, near the village of Edenville. It is both crystallized and massive, but the crystals are too much broken to determine their form with accuracy. It melts alone on charcoal, with the evolution of arsenical fumes, and there remains a black magnetic globule. The associates are powdery red oxide of iron, scorodite, iron sinter, and gypsum in thin scales; the whole being imbedded in white limestone. This

is an exceedingly interesting locality, not only on account of the minerals which it affords, but of the apt illustration which it presents of the changes produced in the mineral kingdom through the influence of chemical agencies.

Putnam County. This mineral occurs in many parts of this county, but only two localities are of much importance. They are within a few rods of each other, and are about four or five miles northwest from Carmel, and near Brown's serpentine quarry in the town of Kent. The one is an old mine hole, from which silver is said to have been obtained. The shaft, which is about forty feet deep, was cleared out a few years since. The yellow pulverulent sulphuret of arsenic covered the sides of the shaft and the timbers wherever they had been immersed in the water, and no doubt resulted from the decomposition of the arsenical pyrites. Mr. Mather expresses the opinion that the latter mineral is not in the form of a vein, but that it exists in a mass, and he supposes it may be in great quantitiy.* He also states that a loose mass of arsenical iron pyrites, weighing from two to three hundred pounds, said to have been dug out of the road, was seen about three miles west of the mine above mentioned, and perhaps a mile from Boyd's corners in the town of Kent.

The other locality is about twenty rods from the preceding, and may be a continuation of the same deposit. It has not been much worked, but specimens may be obtained, of both the crystallized and massive varieties. The forms observed in this vicinity are those represented in Fig. 468, *unitaire* of Haüy; Fig. 469, *unibinaire* of Haüy; and Fig. 470. M on M′ 111° 18′; M on *a* 136° 20′; M on *l* 115° 32′; *l* on *l* 80° 24′; *l* on *z* 160° 49′; *z* on *z* 118° 46′.

Fig 468.

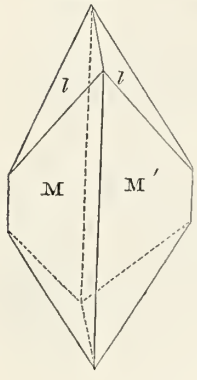


Fig. 469.

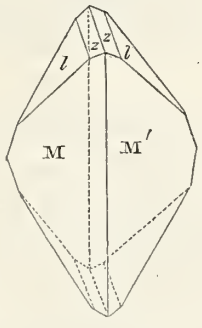
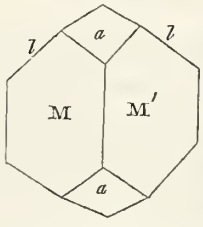


Fig. 470.



As arsenic is converted to various uses in the arts, it is not improbable that these localities may hereafter be advantageously wrought.

Arsenical iron pyrites occurs at Monroe and Chatham in Connecticut, and at Worcester in Massachusetts; but the most interesting deposit is said to be found at Franconia in New-Hampshire.

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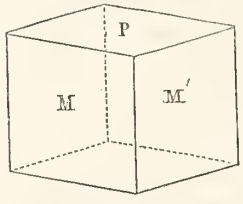
* *New-York Geological Reports*, 1839.

SCORODITE.

[From the Greek σκοροδον, *garlic*; in allusion to its odour under the blowpipe.]

Scorodite. *Cleaveland, Beudant, Phillips* and *Thomson.* — Cuivre Arseniaté Ferrifère. *Haüy?* — Peritomes Flus-Haloid. *Mohs.* — Cube Ore. *Shepard?* (This mineral was incorrectly supposed to be an arseniate of copper combined with oxide of iron.)

Fig. 471.



Description. Colour leek-green passing into white, olive-green and liver-brown. Streak white. It occurs regularly crystallized. The primary form is a right rhombic prism. Fig. 471. M on M′ 120° 10′ (*Phillips*). Cleavage imperfect parallel to the planes MM′ of the prism, and to its lesser diagonal. Fracture uneven. Lustre vitreous, inclining to adamantine. Translucent on the edges to semi-transparent. Rather brittle. Hardness from 3.5 to 4.0. Specific gravity 3.16 to 3.30. Before the blowpipe, it gives out an arsenical odour, and melts into a reddish brown scoria which is attracted by the magnet; with fluxes, it exhibits the bottle-green colour characteristic of iron. It is soluble in nitric and muriatic acids.

Composition. Arsenious acid 31.40, protoxide of iron 36.25, sulphuric acid 1.54, protoxide of manganese 4.00, lime 2.00, magnesia 2.00, water 18.00 (*Ficinus*).

Geological Situation. This mineral is associated with arsenical iron pyrites and other minerals, and occurs in white limestone.

Orange County. Scorodite has heretofore been found in the United States, only on the farm of Mr. B. Hopkins, near the village of Edenville in the town of Warwick. It is in the form of minute crystals and druses of a leek-green, grass-green and greenish white colour. Before the blowpipe it fuses readily, with the extrication of arsenical fumes, into a magnetic scoria. It is associated with arsenical pyrites, iron sinter, oxide of iron, etc., and is found in a vein in white limestone.

IRON SINTER.

Iron Sinter. *Shepard.* — Diarsenate of Iron. *Thomson.* — Untheilbarer Retin-Allophon. *Mohs.*

Description. Colour yellowish grey, reddish or blackish brown. It occurs in kidney-form pieces, soft, approaching to friable. Fracture coarse and earthy, sometimes conchoidal. Lustre vitreous to dull. Soft. Specific gravity 2.40. Before the blowpipe, it intumesces, and some varieties emit a strong arsenical odour, during which they are partly volatilized.

Composition. Arsenic acid 30.25, peroxide of iron 40.25, water with a trace of sulphuric acid 28.50 (*Karsten*).

LOCALITIES.

This mineral was first found by Friesleben in some old mines in the neighbourhood of Freyberg in Saxony, and it appears to have been the result of the decomposition of some of the ores of arsenic and iron. It is not constant in its composition, as the analysis of Klaproth, quoted by Shepard, shows only the presence of oxide of iron, sulphuric acid and water.

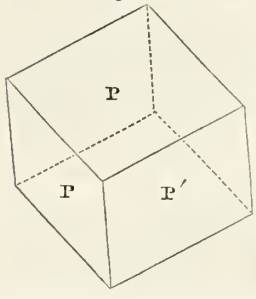
There is associated with the arsenical iron pyrites and scorodite found on Hopkins' farm near Edenville in Orange, a substance which is probably identical with the mineral above described. It occurs in the form of a dull or earthy coating of a chrome yellow, orange yellow or yellowish white colour, sometimes brown on the surface and yellow within. It adheres to the tongue, and may be crushed by the nail. When heated, it gives out water and arsenious acid, and at length fuses into a dark brown or black scoria which is attracted by the magnet. No sulphur or sulphuric acid seems to be contained in this mineral. I formerly supposed it to be a compound of sulphur and arsenic. It is probably formed by the decomposition of the arsenical iron pyrites.

SPATHOSE IRON.

[So named from its *sparry* appearance.]

Fer oxidé carbonaté. *Haüy.* — Spathose Iron. *Phillips.* — Carbonate of Iron. *Cleaveland* and *Thomson.* — Rhombohedral Sparry Iron. *Jameson.* — Brachytyper Parachroz-Baryt. *Mohs.* — Sidérose. *Beudant.* — Spathic Iron. *Shepard.*

Fig. 472.



Description. Colour yellow, white, brown and black. Streak white. It occurs regularly crystallized; also massive and disseminated. The primary form is a rhombohedron, the faces of which are sometimes curvilinear. Fig. 472. P on P′ 107°. Cleavage parallel with the sides of the primary. Fracture sometimes splintery. Lustre brilliant or pearly. Translucent to opaque. Rather brittle. Hardness from 3.5 to 4.5. Specific gravity from 3.30 to 3.90. Before the blowpipe, it blackens and becomes magnetic, but does not melt; with borax, it becomes bottle-green in the reducing flame, and yellow in the oxidating one. Difficultly soluble in acids, unless reduced to fine powder.

Composition. Protoxide of iron 57.50, carbonic acid 36.00, oxide of manganese 3.30, lime 1.25 (*Klaproth*). It is a carbonate of the protoxide of iron. Formula $FeO.CO_2$.

Geological Situation. Occurs in primitive and transition rocks. In the State of New-York, it is almost always associated with specular iron ore.

Uses. When abundant, this is a very valuable ore of iron. It is thought to be peculiarly adapted to the manufacture of steel.

LOCALITIES.

Jefferson County. At the Sterling ore bed in the town of Antwerp, spathose iron is found in rhombohedrons of a yellow and reddish brown colour, with crystallized quartz, specular iron, and the rare cacoxenite. It is not abundant, and it probably passes into the ankerite described further on.

St. Lawrence County. At the Dodge ore bed in the town of Hermon, this mineral occurs in the form of primary crystals, which are of a yellowish colour, and have their faces bent.

Schoharie County. The septaria found in this county and elsewhere, usually have minute crystals of a dark brown colour, with a semi-metallic lustre. They line the seams and cavities, and are usually associated with heavy spar.

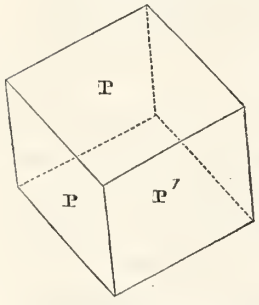
In Connecticut, there is a vein of spathic iron of considerable extent at Roxbury, where it is associated with quartz in a mountain of gneiss.

ANKERITE.

[In honor of Prof. Anker, of the Johannæum in Gratz.]

Ankerite. *Phillips* and *Thomson.* — Paratomous Limestone. *Jameson.* — Paratomes Kalk-Haloid. *Mohs?*

Fig. 473.



Description. Colour white, sometimes tinged with yellow and brown. Streak white. It occurs in crystals or crystalline masses. The primary form is a rhombohedron. Fig. 473. P on P′ 106° 12′. Cleavage perfect, parallel with the primary faces. Fracture uneven. Lustre vitreous. Slightly translucent. Hardness from 3.5 to 4.0. Specific gravity from 2.95 to 3.10. Before the blowpipe alone, it becomes black and acts on the magnet, but does not melt; with borax, it melts into a pearl. Soluble in nitric acid, with a brisk effervescence.

Composition. Carbonic acid with oxide of iron 35.31, lime 50.11, magnesia 11.85, oxide of manganese 3.08 (*Schrötter*). Carbonate of lime 51.10, carbonate of magnesia 25.70, carbonate of iron 2.00, carbonate of manganese 3.00 (*Berthier*).

Geological Situation. This mineral was first found in the Styrian mines.

LOCALITIES.

Warren County. There is still some uncertainty in regard to this mineral. It seems to be intermediate in composition between brown spar and the true spathose iron, the transition being oftentimes almost imperceptible. I received a specimen from Dr. Emmons, the locality of which is Johnsburgh in the above county, which more nearly approaches this species than any other. This mineral has a dark brown colour, and a somewhat metallic lustre. Specific gravity 2.88. Hardness about 3.5. The angle of the rhombohedron is about 106°, but the

faces of the crystal are somewhat curved as in pearl spar. Before the blowpipe it decrepitates, but at length becomes of a darker colour, and is slightly attracted by the magnet. It is soluble with effervescence in dilute muriatic acid. An analysis gave the following results :

Carbonic acid,	45.00
Lime,	28.00
Magnesia,	13.75
Protoxide of iron,	11.25
Moisture and loss,	2.00

Except in the absence of a small proportion of manganese, the above composition is quite similar to that of the ankerite by Berthier above given.*

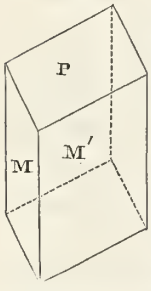
Specimens resembling the above, are also found in the rock accompanying the iron ore at the Parish ore bed in St. Lawrence county. But the carbonate of lime and carbonate of iron are so liable to accidental mixtures, that the minerals having this composition require to be particularly examined.

In Massachusetts, ankerite is said to have been found in the coal formation at West-Springfield.

COPPERAS.

Fer Sulfaté. *Haüy.* — Sulphate of Iron. *Cleaveland* and *Phillips.* — Copperas. *Shepard.* — Hemiprismatic Vitriol. *Jameson.* — Hemiprismatisches Vitriol-Salz. *Mohs.* — Mélanterie. *Beudant.*

Fig. 474.



Description. Colour various shades of green passing into white, but more frequently, owing to exposure, it is externally of a yellow or yellowish brown colour. Streak white. It occurs massive, pulverulent, and in stalactites. By solution it may be obtained in crystals, the primary form of which is an oblique rhombic prism. Fig. 474. M on M′ 82° 21′; P on M 99° 23′. Cleavage parallel to P perfect, less so parallel to M. Fracture conchoidal. Lustre vitreous. More or less translucent or transparent. Hardness 2.0. Specific gravity from 1.84 to 1.97. Before the blowpipe on charcoal, it becomes magnetic, and colours glass of borax green. Its solution in water becomes black on being mixed with the tincture or infusion of galls ; and with chloride of barium, it gives an abundant white precipitate.

Composition. Protoxide of iron 25.70, sulphuric acid 28.90, water 45.40 (*Berzelius*). The formula of pure copperas is $FeO.SO_3+7Aq$.

Geological Situation. It is almost always found associated with iron pyrites, from the decomposition of which it has its origin. It most frequently accompanies coal.

After the statement that has been made in regard to the occurrence of this species as the result of the decomposition of iron pyrites, it will not be necessary to refer to particular

* *Traité des Essais par la voie sèche.* I. 494.

localities. Those pyrites which are subject to decomposition usually afford specimens of the sulphate of iron, either in its pure form, or mixed with alumina. Prof. Shepard remarks, that numerous localities of copperas have been found in New-England, "in which it exists in the form of crusts upon the surfaces of those mica slate rocks, which happen to abound in iron pyrites."*

ALUMINA-SULPHATE OF IRON.

This mineral, described by Dr. Thomson, is said to have been found abundantly in the shale of the wrought out coal beds at Hurlet and Campsie, near Glasgow.

Description. Colour snow-white. It occurs in fine needles about an inch long, having some breadth, but no sensible thickness. Taste sweet and astringent. Soluble in water. When heated, it loses water and becomes red.

Composition. Sulphuric acid 35.60, protoxide of iron 13.56, alumina 7.13, water 43.71 (*Thomson*). Sulphuric acid 28.64, protoxide of iron 19.93, alumina 2.85, water 48.58 (*Thomson*).

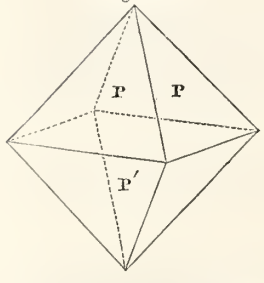
From the above analyses, and those of Berthier and Phillips, it appears that the mineral varies considerably in its composition.

A mineral resembling the one here described, is found associated with the lignite, clay and iron pyrites at Rossville in Richmond county.

CHROME-IRON ORE.

Fer Chromaté. *Haüy.* — Chromate of Iron. *Cleaveland* and *Phillips.* — Chrome-iron Ore. *Thomson.* — Chrome Ore. *Shepard.* — Octahedral Chrome Ore. *Jameson.* — Octaedrisches Chrom-Erz. *Mohs.* — Eisenchrome. *Beudant.*

Fig. 475.



Description. Colour iron-black or brownish black. Streak brown. It occurs regularly crystallized; also massive and disseminated in grains. Primary form the regular octahedron, Fig. 475. Cleavage parallel with the primary, but imperfect. Fracture uneven. Lustre imperfectly metallic. Opaque. Hardness 5.5. Specific gravity from 4.32 to 4.50. Occasionally magnetic. Infusible by the blow-pipe alone; with borax, it melts slowly, and on cooling, exhibits the fine green colour of the oxide of chrome. It is insoluble in nitric acid.

Composition. *Specimen from Bare hills near Baltimore* — Green oxide of chrome 52.95, peroxide of iron 29.24, alumina 12.22, white matter 3.09, water 0.70 (*Thomson*). Formula $FeO+Cr_2O_3$.

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* *Treatise on Mineralogy.*

Dr. Thomson remarks, that the reason of the difference in the results of Vauquelin, Laugier, Klaproth, Seybert and Berthier, is that they did not employ pure specimens. He denies that silica is essential to the mineral, as has been asserted by Berthier and others.

Geological Situation. This mineral occurs in beds, veins and detached grains or crystals, in serpentine, porphyry and trap rocks. In this State, it is found only in small quantities in the beds of serpentine, and of the allied minerals.

Uses. Chrome-iron ore is employed in the manufacture of the chromates, some of which are highly esteemed and largely used as paints.

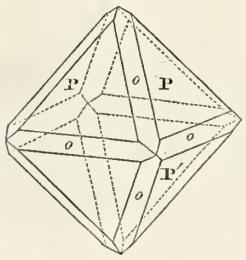
LOCALITIES.

Putnam County. Crystals of chrome-iron ore are occasionally met with in the serpentine and magnesian carbonate of lime at Hustis' farm in Phillipstown. A crystal has been obtained here, with the base a quarter of an inch in diameter. It resembles black spinelle, but its powder is attracted by the magnet, and its blowpipe characters agree with those just noticed.

Minute grains or crystals of the same mineral have also been found in the vicinity of Carmel, in this county.

Orange County. Minute octahedrons of chrome ore are found in a talcy mineral accompanying a bed of magnetic iron ore, at the Wilks mine in the town of Monroe.

Fig. 476.



Richmond County. Octahedral crystals of this mineral have long been credited to the serpentine at the Quarantine and elsewhere in this county. It is probable that they have sometimes been nothing more than magnetic iron ore.

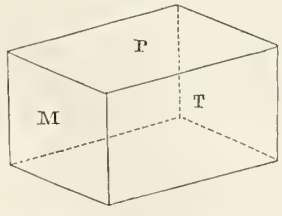
Westchester County. The serpentine near Rye and New-Rochelle, contains black metallic grains, which are supposed to be chrome iron ore.

Fig. 476 represents a modified octahedron of this mineral, found at Hoboken in New-Jersey (*Shepard.*)

VIVIANITE.

Fer Phosphaté. *Haüy.* — Phosphate of Iron. *Cleaveland* and *Phillips.* — Vivianite. *Thomson* and *Shepard.* — Prismatic Blue Iron. *Jameson.* — Dichromatisches Euklas-Haloid. *Mohs.*

Fig. 477.



Description. Colour varying from pale green to indigo-blue. Streak bluish white, but on exposure changing to indigo blue. It occurs regularly crystallized; also massive, disseminated, and in thin coats. Primary form a right oblique angled prism. Fig. 477. M on T 125° 18′. Cleavage perfect parallel to P. Lustre pearly, inclining to metallic, on P; on the other faces, vitreous. Varies from transparent to opaque. Hardness from 1.5 to 2.0. Specific gravity 2.66.

Before the blowpipe on charcoal, it intumesces and melts into a globule of a dark brown or black colour, and which, when the heat is continued, becomes magnetic. Soluble without effervescence in muriatic acid.

Varieties. *Earthy Blue Iron.* This variety of phosphate of iron, sometimes called *Native Prussian Blue*, occurs in a friable or loosely cohering state. On its first exposure, its colour is grey, yellow or greenish white; afterwards it acquires a blue colour of different degrees of intensity.

The *Mullicite* of Thomson, is also identical with this species.

Composition. *Vivianite*—Protoxide of iron 41.23, phosphoric acid 31.18, water 27.49 (*Stromeyer*).

Earthy Phosphate—Protoxide of iron 32.00, phosphoric acid 47.50, water 20.00 (*Klaproth*).

Mullicite, from New-Jersey—Protoxide of iron 42.65, phosphoric acid 24.00, water 25.00, quartz sand 7.90 (*Thomson*).

All these varieties, therefore, are hydrous phosphates of iron.

Geological Situation. The crystalline varieties are often found in primary rocks, and in clays associated with bog iron ore. The earthy and friable varieties occur in peat bogs. These are sometimes used as paints.

LOCALITIES.

Vivianite occurs in crystals, in the fissures of the gneiss rock, along with stilbite, feldspar, etc. at Harlem, N. Y. The colour of the crystals is a dirty blue. The form is the primary, with the terminal edges replaced by planes. Before the blowpipe, these crystals melt into a black scoria, which is attracted by the magnet. In New-Jersey, this mineral occurs at Allentown in Monmouth county, and in various other parts of the State. It generally accompanies bog iron ore and other argillaceous deposits, and is both crystalline and earthy.

CACOXENITE.

[From the Greek κακος, *bad*, and ξενος, *a guest;* because its presence is injurious to iron ore.]

Kakoxene. *Phillips* and *Mohs*, App. — Cacoxenite. *Thomson.* — Variety of Klaprothine. *Beudant.*

Description.* Colour dull yellow of different tints. Streak yellowish red. It occurs in extremely minute filamentous crystals, generally disposed in diverging groups, radiating from a point; and which are said to be irregular six-sided prisms terminated by pyramids of six faces; also in the form of a yellowish powder, when it much resembles the common ochrey

* This mineral was first described by J. Steinmann, Professor of Chemistry in the University of Prague. *Brewster's Edinburgh Journal of Science.* V. 163.

brown iron ore. Lustre silky. Adheres to the tongue. Soft. Sectile. Specific gravity 2.336 (*Richardson*). Before the blowpipe on charcoal, it decrepitates, and assumes a dark red brown colour, but does not melt; with borax, it fuses readily into a dark red coloured bead. Heated alone in a glass tube, it gives off water, and the colour changes to a dark brown.

Composition. Phosphoric acid 17.86, peroxide of iron 36.32, silica 8.90, alumina 10.01, lime 0.15, water and fluoric acid 25.95 (*Steinmann*). Phosphoric acid 20.50, peroxide of iron 43.10, silica 2.10, lime 1.10, magnesia 0.90, water 30.20, oxide of manganese a trace (*Richardson*).

Geological Situation. This mineral was first found at Urbeck in Bohemia, associated with clay ironstone, which occurs in the coal formation. It has also been found with specular iron ore, in the Potsdam sandstone.

LOCALITIES.

Cacoxenite has been found in considerable abundance, accompanying the specular iron ore and crystallized quartz, at the Sterling iron mine in the town of Antwerp, Jefferson county. The mineral occurs here in minute radiated tufts or stars made up of leaves or fibres, which somewhat resemble iron pyrites. The colour, when recently exposed, is yellow; but the surface becomes brown, and somewhat pulverulent, on exposure. The lustre of the blades is silky, or approaching to metallic. Alone before the blowpipe, it is infusible, but becomes of a darker colour, and is attracted by the magnet. In this respect it differs from karpholite, which is said to be fusible.

Inferior specimens of this mineral are also found associated with red oxide of iron, on Mount Defiance, near Ticonderoga, Essex county.

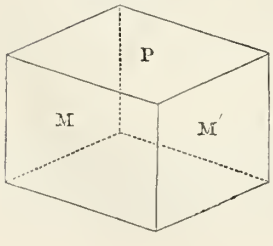
Prof. Shepard suggests that this mineral is a mere variety of Wavellite, and Beudant introduces it as an appendix to his Klaprothine, the Azurite of Phillips; but it seems to me to be quite distinct from both those species.

ILVAITE.

[From the island of *Elba*, where it was first found.]

Fer Calcareo-Siliceux. *Haüy.* — Yenite. *Cleaveland*, *Phillips* and *Shepard.* — Ilvaite. *Thomson* and *Beudant.* Diprismatic Iron-Ore, or Lievrite. *Jameson.* — Diprismatisches Melan-Erz. *Mohs.*

Fig. 478.



Description. Colour black, with a shade of brown or green. Streak black, sometimes inclining to green or brown. It occurs regularly crystallized; also in masses composed of diverging fibres, and amorphous. Primary form a right rhombic prism. Fig. 478. M on M′ 112° 37′ (*Lelievre*); 112° (*Brooke*). Cleavage distinct parallel with the longer diagonal of the prism; less so parallel with M. Fracture conchoidal and uneven. Lustre semi-metallic. Opaque. Brittle. Hard-

ness from 5.5 to 6.0. Specific gravity from 3.82 to 4.06. Before the blowpipe on charcoal, it fuses with slight intumescence into a black globule, which is strongly attracted by the magnet, if not heated to redness ; with borax, it melts into a dark green and almost opaque glass. It forms a jelly with heated muriatic acid.

Composition. Protoxide of iron 52.54, silica 29.28, lime 13.78, oxide of manganese 1.59, alumina 0.61, water 1.27 (*Stromeyer*).

Geological Situation. The principal locality of this mineral is the island of Elba, where it is found associated with epidote, garnet and iron ore, in limestone. It has also been met with in Norway and Siberia.

LOCALITIES.

According to Dr. Emmons, this species occurs in Essex county ;* but I am not acquainted with the precise locality, nor can I give any further account of it.

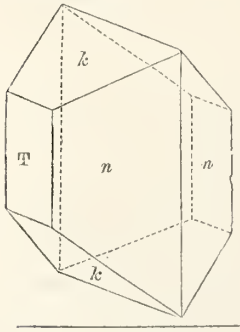
Ilvaite or yenite, according to Shepard, has been found at Cumberland, Rhode-Island, in slender crystals in quartz, associated with hornblende and magnetic iron ore.

SILICATE OF IRON.

Description. In the slag from the furnace for the cementation of steel, at Ramapo in Rockland county, there are often found cavities lined with short four and six-sided prisms with dihedral summits, as in Fig. 479. They have an iron black colour and metallic lustre, slightly magnetic. Easily fusible by the blowpipe into a bright iron-blue globule, which is attracted by the magnet.

Composition. Protoxide of iron 70.00, silica 30.00. It is therefore a silicate of iron : $FeO.SiO_3$.

Fig. 479.



This mineral has the same composition as the anhydrous silicate of iron of Thomson, but the latter is said to be infusible by the blowpipe. It is, however, exactly similar to the artificial silicate described by Mitscherlich as formed during the refining process of cast iron, and which has the crystalline form of peridot, Fig. 479, The primary being a right rectangular prism.† T on *n* 114° 6′; T on *k* 138° 31′.

The same product is noticed by Beudant, under the name of *peridot* with a base of iron.‡

* *New-York Geological Reports.* 1839.

† *Brewster's Edinburgh Journal of Science.* II. 129. — In this paper, Prof. Mitscherlich notices the occurrence of scoriæ at Fahlun and Garpenberg in Sweden, and in several of the foundries of Germany, possessing the same form and composed of the same elements as certain minerals found in nature.

‡ *Traité des Essais par la Voie Sèche.* I. 445.

HUDSONITE.

Description. Colour black, often with a brownish tarnish. Streak green. It occurs massive, exhibiting one very perfect cleavage like some varieties of pyroxene. Lustre vitreous to resinous. Opaque. Hardness from 4.5 to 5.0. Specific gravity 3.50. Alone before the blowpipe, it fuses with effervescence into a black bead, which is attracted by the magnet.

This mineral, which is proposed as a new species, was found by Dr. Horton in a vein of quartz in the town of Cornwall, Orange county. Its composition, according to my analysis, is as follows, viz:

Silica,	37.90
Oxide of iron,	36.80
Alumina,	12.70
Lime,	11.40
Magnesia,	1.92

It agrees more nearly with the *Polylite* of Dr. Thomson, than any other mineral with which I am acquainted. He describes that species as being found in a bed, in magnetic iron ore, at Hoboken in New-Jersey. Colour black; composed of plates; but one cleavage discernible. It resembles hornblende, or still more arfwedsonite in its appearance. Hardness 6.25. Alone it does not fuse.*

The composition of Dr. Thomson's mineral is as follows, viz:

Silica,	40.04
Protoxide of iron,	34.08
Protoxide of manganese,	6.60
Alumina,	9.42
Lime,	11.54
Water,	0.40

As it regards composition, the hudsonite differs in its not containing oxide of manganese, for which it was carefully tested, and in its smaller proportion of lime. It strikingly differs also in its hardness, and in the ease with which it is fused by the blowpipe. The powder, which is green, has its colour heightened by the application of heat.

Opposed as I am to the introduction of new species on slight grounds, it is with some hesitation that the above name, in allusion to the river in the vicinity of which it occurs, has been proposed for the mineral in question. But the characters which it exhibits seem to me to be sufficiently important to warrant its separation.

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* *Outlines of Mineralogy, Geology, &c.* There is undoubtedly a mistake in regard to the locality of this mineral as above given. I am not aware of the existence of a bed of magnetic iron ore at Hoboken. Our mineral is in a gangue of white quartz, and has apparently not been exposed to admixture of any kind, except perhaps of silica. But the black hudsonite and white quartz are entirely distinct in all the specimens which I have seen, and seem never to pass into each other.

ORDER II. MANGANESE.

The following species occur in New-York, viz:

1. Oxide of Manganese. 2. Manganese Spar. 3. Babingtonite.

OXIDE OF MANGANESE.

I have already noticed the principal localities of the common earthy Oxide of Manganese, or Wad (see page 53).

A crystalline mineral, which probably is the *Grey Oxide of Manganese* of Phillips, is found in nests and geodes in the hematitic iron ore at Unionvale in Dutchess county. These masses are made up of very minute crystals of a steel or lead-grey colour, resembling specular iron ore. The crystals are apparently rhombic prisms. They have a high metallic lustre, and are easily reduced to powder.

The composition, according to my analysis, is as follows, viz:

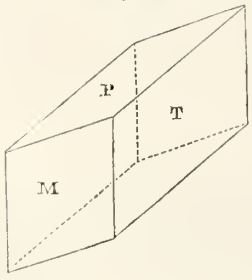
Oxide of manganese,	83.33
Oxide of iron and alumina,	6.16
Water,	10.00

Haidinger has remarked that the geodes of brown hematite at Huttenburg in Carinthia are often adorned with crystals of arragonite, of calcareous spar, of prismatic manganese ore, or with silvery flakes of another manganesian mineral whose exact composition has not been ascertained.* So far as it relates to the manganese ore, and the silvery flakes, the same remark is applicable to the hematitic geodes which occur at Unionvale.

MANGANESE SPAR.

Siliceous Oxide of Manganese. *Cleaveland.* — Silicate of Manganese. *Thomson.* — Siliciferous Oxide of Manganese. *Phillips.* — Manganese Spar. *Shepard.* — Diatomer Augit-Spath. *Mohs.* — Rhodonite. *Beudant.*

Fig. 480.



Description. Colour pale rose-red. Streak white. It occurs massive, but the cleavage is apparent in two directions perpendicular to each other, exhibiting as the primary form a doubly oblique prism, Fig. 480; that parallel to P, highly perfect. M on T 121°; M on P 93° to 94°; T on P 112° 30′. Fracture even, or flat conchoidal. Lustre between pearly and resinous. Transparent to translucent. Hardness from 5.5 to 6.0. Specific gravity from 3.50 to 3.90. Alone before the blowpipe on charcoal, it becomes dark brown, and melts

* *Brewster's Edinburgh Journal of Science.* IX. 382.

into a reddish-brown or black globule; with borax, it forms a violet-coloured glass. When in powder, it is partly soluble in muriatic acid, the residuum assuming a white colour.

Composition. *Specimen from Langbanshytta* — Protoxide of manganese 49.04, silica 48.00, lime 3.12, magnesia 0.22, oxide of iron, traces (*Berzelius*). It is probably a true silicate of manganese. Formula $MnO.SiO_3$.

Specimen from Franklin, New-Jersey — Protoxide of manganese 66.60, silica 29.64, peroxide of iron 0.92, moisture 2.70, alumina a trace (*Thomson*). This differs much from the preceding.

Geological Situation. This mineral usually occurs with magnetic iron ore in primitive rocks.

LOCALITIES.

According to Dr. Emmons, silicate of manganese has been found in this State in the counties of Essex and Warren.

This species occurs at Franklin and Sterling, New-Jersey; at the former of which, it is associated with magnetic iron ore, franklinite, etc.; and at the latter, with the red zinc ore, troostite, etc. It is also found in large rolled masses, at Cummington in Massachusetts.

The *Sesquisilicate* and *Bisilicate of Manganese* of Thomson, credited to Franklin in New-Jersey, are perhaps not distinct from this species; to which also *Fowlerite*, and according to Beudant, *Torrelite* should be referred. These minerals, however, differ considerably from the true manganese spar in the proportions of their constituents.

BABINGTONITE.

[In compliment to Dr. Babington.]

Babingtonite. *Levy, Phillips* and *Thomson.* — Axotomer Augit-Spath. *Mohs.*

Description. Colour dark greenish black. It occurs regularly crystallized. The primary form, according to Levy, is a doubly oblique prism. Fig. 481. P on M 92° 34′; P on T 88°; M on T 112° 30′. But it usually crystallizes in eight-sided prisms. Fig. 482. *g* on *m* 132° 15′; *h* on *m* 137° 05′; *h* on *t* 155° 25′ (*Levy*). Sometimes the faces *m* are wanting. Cleavage perfect parallel to P; less so to *t*. Fracture imperfect conchoidal. Lustre vitreous. Thin splinters faintly translucent. Hardness from 5.5 to 6.0. Specific gravity from 3.40 to 3.50. Before the blowpipe alone, it fuses into a black enamel; with borax, it gives a transparent violet globule, which in the reducing flame becomes bluish green.

Fig. 481.

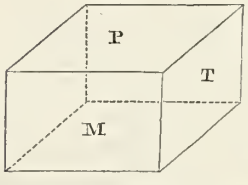
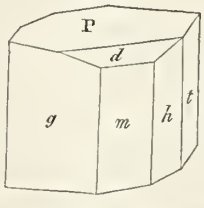


Fig. 482.



This mineral resembles some dark varieties of pyroxene, from which it was first distinguished by Mr. Levy. Mr. Children found it to contain silica, iron, manganese, lime, and a minute quantity of titanium.

LOCALITY.

St. Lawrence County. The only known locality of babingtonite in the United States, is at Gouverneur in this county, where it was first noticed by Prof. Shepard, coating crystals of feldspar.

ORDER III. ZINC.

This order contains only a single species, viz :

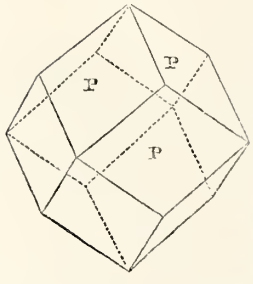
1. Zinc Blende; and to this may be added the artificial oxide known by the name of Cadmia.

ZINC BLENDE.

[From the German, signifying *glistening;* in allusion to its lustre.]

Zinc Sulfuré. *Haüy.* — Sulphuret of Zinc. *Cleaveland* and *Phillips.* — Blende, or Sulphuret of Zinc. *Thomson.* — Dodecahedral Zinc-Blende. *Jameson.* — Dodecaedrische Granat-Blende. *Mohs.* — Blende. *Beudant* and *Shepard.*

Fig. 483.



Description. Colour brown, yellow, grey, green, red and black. Streak varying with the colour. It occurs regularly crystallized; also massive and disseminated. Primary form the rhombic dodecahedron, Fig. 483. Its secondary forms are very numerous. Cleavage perfect, parallel with the primary faces. Fracture conchoidal. Brittle. Lustre splendent, sometimes adamantine. Varies from transparent to opaque. Hardness from 3.5 to 4.0. Specific gravity from 4.00 to 4.20. Before the blowpipe, it usually decrepitates; and though generally infusible even with borax, it sometimes melts into a scoria (*Thomson*). Its powder in sulphuric acid gives out sulphuretted hydrogen. Difficultly soluble in nitric acid; its solution giving a white precipitate with ammonia, which is soluble in an excess of the alkali.

Zinc blende may be distinguished from those varieties of galena, garnet and oxide of tin, which it sometimes resembles, by the ease with which it yields to cleavage in the direction of the primary faces.

Varieties. There are different varieties of this mineral, depending upon the structure, as the *crystallized*, the *lamellar*, the *fibrous*, etc.; also depending upon the colour, as the *yellow*, the *brown*, and the *black blende*.

Composition. Zinc 66.34, sulphur 33.66 (*Arfwedson*). There can be no doubt that this mineral, when pure, is a true sulphuret of zinc, which is composed of 67 zinc and 33 sulphur, or one atom of each of the constituents. But the specimens generally contain variable proportions of iron, sometimes from eight to ten per cent. Formula ZnS.

Geological Situation. This mineral is usually associated with galena, whether it occurs in primary or transition rocks. With the association of the ore of lead, it is found in the limestones of the western part of the State. In St. Lawrence and Sullivan counties, it is often in large quantities.

Uses. Zinc blende is employed in the manufacture of sulphate of zinc, or *white vitriol*. For this purpose, it is subjected to heat in a reverberatory furnace, or exposed to the action of air and moisture; by either of which processes, the blende attracts oxygen, and is converted into the sulphate of zinc. This mineral is also sometimes used for obtaining metallic zinc, but the reduction is more difficult than with some other ores of this metal.

LOCALITIES.

Columbia County. Zinc blende is found in various parts of this county, associated with galena and some ores of copper. At the Ancram lead mine, the massive yellow and brown varieties both occur, but the latter is the most abundant. The analysis of these varieties gave the following results, viz:

	I.	II.
Sulphur,	33.56	33.20
Zinc,	61.64	57.85
Iron,	4.30	6.45
Gangue,	0.50	2.50

No. I. was compact; No. II. foliated.

This mineral is also found at Livingston's lead mine, and near Whiting's pond in the town of Canaan, where it is also associated with galena in small veins.

Dutchess County. As the veins of galena found in the preceding county extend into this, blende is probably associated with that mineral. No very important locality, however, has yet been reported.

Herkimer County. On the farm of Judge Hurlbut, in the town of Salisbury, about half way between the East and West-Canada creeks, is a small vein of zinc blende associated with iron pyrites. Mr. Vanuxem states that this mineral, associated with galena, iron and copper pyrites, is found near Salisbury corners.

Lewis County. The brown variety, both granular and massive, with galena and calcareous spar, is found in small quantities in veins in the Trenton limestone, near the village of Martinsburgh.

Monroe County. Zinc blende, of a wax-yellow colour, both massive and crystallized, in the form of the dodecahedron (Fig. 483), has been found in cavities in the limestone near Rochester. It is sometimes associated with galena, but the mineral is not abundant, and perfect crystals are exceedingly rare.

Montgomery County. This mineral, in very minute light yellow translucent crystals, occurs, associated with galena, on Flat creek, two miles southeast of Spraker's basin in the town of Root. Among the forms are the dodecahedron (Fig. 483), and the regular octahedron, Fig. 484. g on m, or g' on m' 109° 28′ 16″.

Fig. 484.

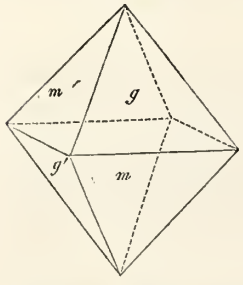
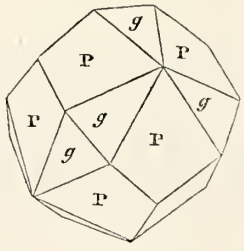


Fig. 485.



Niagara County. Crystals of zinc blende, having a fine honey and wax-yellow colour, are found in the limestone at Lockport. They are translucent and transparent; have the form of the octahedron, the dodecahedron (Fig. 483 and 484), and of that represented in Fig. 485 (*Horton*).

Similar crystals are found on Goat island, near Niagara falls. They are in the form of the dodecahedron, but usually imperfect. They are sometimes flattened, and have some of the angles rounded.

Oneida County. There are several localities of zinc blende in this county. Near Hamilton College, it has been found in yellow and nearly transparent crystals. The yellow massive variety is found near the villages of Rome and Vernon.

Orange County. In the Highlands, zinc blende occurs black, opaque, nearly dull, and resembling some varieties of hornblende. It is not abundant.

St. Lawrence County. Since the opening of the lead mines in this county, zinc blende has been found in various places, and in some instances in considerable quantity. At Cooper's falls, it is met with in a vein of carbonate of lime. At Mineral point, the massive variety is in a vein accompanying galena, in a similar gangue. The blende at both these localities has a brown colour and foliated structure. A specimen from Mineral point had the following composition, viz:

Sulphur,	32.80
Zinc,	59.40
Iron,	6.30
Gangue and loss,	1.50

On the farm of Mr. Belmont in the town of Fowler, there is, according to Dr. Emmons, a vein made up in about equal proportions of zinc blende, iron and copper pyrites. It is about

eight inches in width, has a course NNE. and SSW., and traverses a bed of serpentine forty or fifty feet in width.

Sullivan County. In the Shawangunk mountains, about two miles west of the village of Wurtzboro', and three quarters of a mile from the Hudson and Delaware canal, there is an interesting deposit of zinc blende, galena, copper pyrites, with occasional masses and crystals of iron pyrites. The whole is found in the millstone grit, of which the mountain is composed. The zinc blende is both crystallized and massive. The crystals are small, black, and very perfect tetrahedrons, Fig. 486; and of the same form with the solid angles replaced by tangent planes, Fig. 487. The massive variety is of various shades of brown, and is often so intimately mixed with the galena that the eye can scarcely determine the line of separation. This circumstance has interfered materially with the processes for the reduction of the lead ore.

Fig. 486.

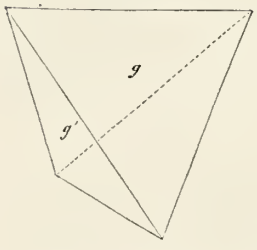
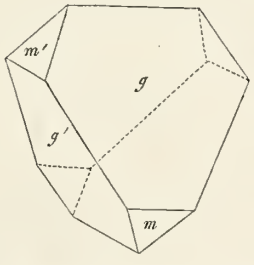


Fig. 487.



Ulster County. Zinc blende has been found in various parts of this county. The best locality is probably that near the village of Ellenville, where it is associated with galena, for which extensive mining operations have been carried on. The specimens have a brown colour, are easily cleavable, and seem to be fragments of large crystals. The vein above mentioned is in the millstone grit or sandstone of which the Shawangunk mountain is composed.

Westchester County. Blende of a dark colour and high lustre, occurs in rounded masses, with copper and iron pyrites, in the dolomitic limestone in Eastchester.

OXIDE OF ZINC, OR CADMIA.

In the chimneys of the iron furnaces at Ancram in Columbia county, and at Amenia in Dutchess, where the hematitic ores are employed, there is often formed a deposit made up of layers of a yellowish or reddish colour, and having a stony hardness. The same substance has been observed in some of the iron furnaces in France, and has been called *Cadmium*, or *Cadmia*. When first obtained from the Ancram furnace, it was supposed to be a native product, and described by Dr. Torrey as a new ore of zinc.* It is now known, however, to result from the minute proportion of sulphuret or oxide of zinc which these ores contain, and which, being volatized by the heat, is again deposited in the form of layers in the chimney of the furnace. The following is the composition of two specimens of cadmia from the Ancram furnace, viz:

* *New-York Medical and Physical Journal*, I. 191.

	I.	II.
Oxide of zinc,	96.10	95.00
Oxide of iron,	2.90	4.50
Carbon,	1.00	0.50

It is, therefore, a nearly pure oxide of zinc. The above results agree very well with those obtained from an examination of similar products in France.

ORDER IV. LEAD.

1. Galena.
2. White Lead Ore.
3. Anglesite.
4. Yellow Lead Ore.
5. Pyromorphite.
6. Vauquelinite.

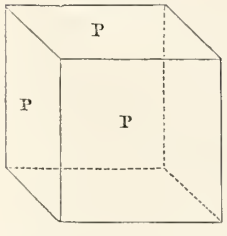
GALENA.

[From the Latin *galena*, an ore of silver and lead.]

Plomb Sulfuré. *Haüy.* — Sulphuret of Lead, or Galena. *Cleaveland.* — Sulphuret of Lead. *Phillips* and *Thomson.* — Hexahedral Galena, or Lead Glance. *Jameson.* — Hexaedrischer Blei-Glanz. *Mohs.* — Galène. *Beudant.*

Description. Colour bluish grey, usually called lead-grey. Streak unaltered. It occurs regularly crystallized; also granular and massive, sometimes having a lamellar structure, and at others almost compact. The primary form is a cube, Fig. 488. Cleavage parallel with the primary planes, highly perfect, and easily obtained. Fracture even, or flat conchoidal. Very frangible and sectile. Lustre brilliant metallic. Opaque. Hardness from 2.5 to 3.0. Specific gravity from 7.40 to 7.65. Fusible before the blowpipe, with the disengagement of fumes of sulphur. When heated on charcoal, the metallic lead is obtained. Soluble in nitric acid, forming a white precipitate of sulphate of lead. When dissolved in dilute nitric acid with only a slight elevation of temperature, the solution produces a precipitate of brilliant blades of lead upon a clean plate of zinc, but not upon a plate of copper, unless it contains sulphuret of silver.

Fig. 488.



Composition. Lead 85.13, sulphur 13.02 (*Thomson*). This is nearly in the ratio of one atom of each of the constituents; but it often contains small quantities of sulphuret of silver. Formula PbS.

Geological Situation. This mineral is found in various formations, as the primary, the transition and the secondary. In this State, it is found in veins in granitic rock, in the Trenton and Lockport limestones, and in the coarse sandstones of the Shawangunk mountains.

Uses. Galena is the ore which is almost exclusively employed in the reduction of the metal.

LOCALITIES.

In the preceding part of this work, I have given a full detail of all the information which was in my possession at the time of its publication, with respect to the localities of this ore, the condition of mining operations, etc. (see page 44). I shall here add only a few notices of the crystalline forms which have been observed, and a few facts in regard to the present situation of some of our lead mines.

Lewis County. In the vicinity of Martinsburgh, several veins of galena have been found, traversing the Trenton limestone. It is usually associated with iron pyrites and the six-sided crystals of calcareous spar. The crystalline forms which have been observed here, are the cube (Fig. 488); the regular octahedron, Fig. 489; the octahedron with one solid angle replaced by a tangent plane, Fig. 490; and the same with all the solid angles replaced, as in Figs. 491 and 492. The crystals are usually small.

Fig. 489.

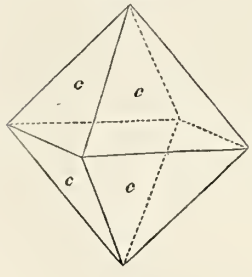


Fig. 490.

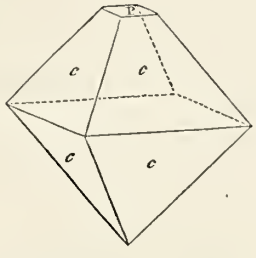


Fig. 491.

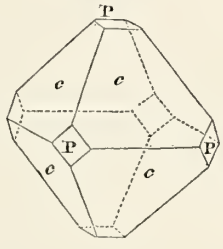


Fig. 492.

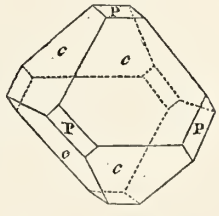
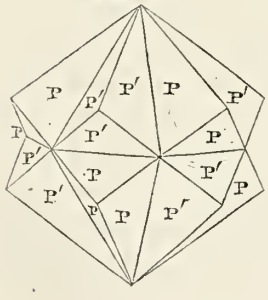


Fig. 493.



Orange County. In the town of Deerpark, galena has recently been found in small quantities. According to Dr. Horton, it sometimes has the form of the cube (Fig. 488), and that of the compound crystal represented in Fig. 493.

St. Lawrence County. The Rossie mines have yielded the finest crystals of galena which have heretofore been found in this State. Some of these are of very large size, and consist of groups variously arranged. They are associated with calcareous spar, iron and copper pyrites, celestine, etc. The most common forms are the cube (Fig. 488); and the cube

Fig. 494.

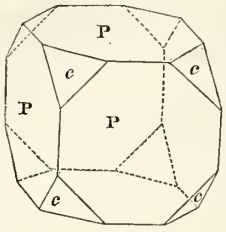
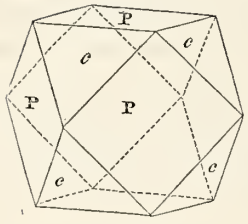


Fig. 495.



with the solid angles replaced by tangent planes, as in Figs. 494 and 495.

At Mineral point on Black lake, the same mineral occurs with similar associates as those at Rossie, in the form of the regular octahedron (Fig. 489), and of the octahedron with two or more solid angles replaced by tangent planes.

Sullivan County. I have heretofore given a full description of the deposits of galena which occur in the vicinity of Wurtzboro'. The mine which is there described as belonging to the New-York and Shawangunk Mining Company, has passed into the hands of the "Sullivan Company." From information recently received, it appears that the ore, which is very abundant, yields about twenty-two per cent. of metallic lead, and about fifty per cent. of zinc blende. No attempts have yet been made to reduce the zinc ore.

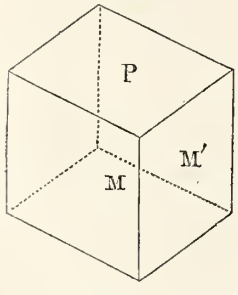
As this mine is one of the most extensive in the State, and has been very judiciously worked, I was desirous of introducing a section of it into this work. The present proprietors have obligingly furnished me with copies of the drawings made in May, 1840, by Mr. John Hitz. A large quantity of ore was then obtained, and since that time the works have not been extended. The ore at this locality is almost entirely massive. A few specimens of small octahedral crystals have, however, been found.

Galena exists in veins at Southampton and Northampton in Massachusetts; at Middletown, Huntington, Southington and Brookfield in Connecticut; at Perkiomen in Pennsylvania; and also in the States of Vermont and Maine. But the most extensive deposits of this ore, found in the world, occur on the Upper Mississipi.

WHITE LEAD ORE.

Plomb Carbonaté. *Haüy.* — Carbonate of Lead. *Cleaveland*, *Thomson* and *Phillips.* — Diprismatic Lead Spar. *Jameson.* — Diprismatischer Blei-Baryt. *Mohs.* — White Lead Ore. *Shepard.* — Ceruse. *Beudant.*

Fig. 496.



Description. Colour white, passing into grey and greyish black; also green and blue by admixtures of copper. It occurs regularly crystallized, and also massive and pulverulent. Primary form a right rhombic prism, Fig. 496. M on M′ 117°. Cleavage parallel to the planes P, M and M′, but not distinctly. Fracture uneven and conchoidal. Lustre adamantine, more or less resinous, and imperfect metallic. Transparent to translucent. Hardness from 3.0 to 3.5. Specific gravity from 6.46 to 6.73. Before the blowpipe, it decrepitates, and changes its colour into yellow and red; upon charcoal, it is easily reduced. When thrown in powder upon ignited charcoal, it yields a phosphorescent light. It is soluble with effervescence in nitric acid. When a bar of zinc is introduced into the solution, it is soon covered with blades of metallic lead.

Composition. Carbonic acid 16.00, oxide of lead 82.00, water 2.00 (*Klaproth*). It is undoubtedly composed of one atom of carbonic acid and one atom of oxide of lead; but it often contains minute portions of alumina, silica, etc. Formula $PbO.CO_2$.

Geological Situation. This mineral is usually associated with galena, being found in veins of granite, gneiss and limestone.

LOCALITIES.

St. Lawrence County. The lead mines of this county have yielded a good deal of carbonate of lead in an impure pulverulent form. It is commonly called *lead ashes*, and contains, besides carbonate of lead, some sulphate of lead and carbonate of lime. These salts of lead have undoubtedly been formed by the decomposition of the galena, by the reäction of the carbonates of lime. Neither of these minerals have been found here in a crystalline form.

A mineral resembling the white lead ore, has also been observed, in small quantities, associated with galena, at Martinsburgh in the county of Lewis.

Westchester County. Small prismatic crystals of the white lead ore, with a high adamantine lustre, associated with galena, copper pyrites, etc., have been found about a mile south of Sing-Sing.*

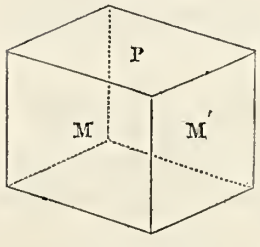
Very well characterized crystals of this mineral were formerly obtained at the Perkiomen mine in Pennsylvania. They have been obtained in abundance at the lead mines in Missouri.

ANGLESITE.

[From its occurring in *Anglesea*, in Cornwall, Eng.]

Plomb Sulfaté. *Haüy.* — Sulphate of Lead. *Cleaveland*, *Phillips* and *Thomson.* — Prismatic Lead Spar. *Jameson.* — Prismatischer Blei-Baryt. *Mohs.* — Anglesite. *Beudant* and *Shepard.*

Fig. 497.



Description. Colour white, grey or yellowish; sometimes green or blue, owing to oxide of copper. Streak white. It occurs regularly crystallized; also massive, disseminated and pulverulent. Primary form a right rhombic prism, Fig. 497. M on M′ 103° 42′. Cleavage parallel with the primary planes. Fracture conchoidal. Lustre adamantine, inclining to vitreous or resinous. Transparent to translucent. Brittle. Hardness 3.0. Specific gravity from 6.23 to 6.31. Fusible by the blowpipe, in the outer flame, into a white slag; in the reducing flame, it effervesces, and is reduced to the metallic state. It is difficultly soluble in nitric acid, without effervescence, in which it differs from white lead ore.

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* Torrey. *Annals of the Lyceum of Natural History of New-York.* IV. 76.

Composition. Oxide of lead 72.47, sulphuric acid 26.09, water 0.12, silica 0.51 (*Stromeyer*). Formula $PbO.SO_3$.

Geological Situation. This mineral, like the last, is almost always associated with galena.

LOCALITIES.

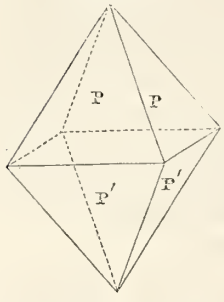
It has already been observed that this mineral, in a pulverulent state, has been found associated with carbonate of lead, at the Rossie mine in St. Lawrence county. It is, of course, the result of decomposition of galena. It has not been observed in a crystalline form at any of our lead mines.

This mineral occurs with galena in the Missouri lead mines, and in that of Southampton in Massachusetts.

YELLOW LEAD ORE.

Plomb Molybdaté. *Haüy.* — Molybdate of Lead. *Cleaveland, Phillips* and *Thomson.* — Pyramidal Lead Spar. *Jameson.* — Pyramidaler Blei-Baryt. *Mohs.* — Yellow Lead Ore. *Shepard.* — Melinose. *Beudant.*

Fig. 498.



Description. Colour usually orange or wax-yellow, passing into grey or brown, rarely green or red. Streak white. It occurs regularly crystallized; also massive, in crusts and cellular. Primary form the octahedron with a square base. Fig. 498. P on P′ 131° 15′; P on P and P′ on P′ 99° 50. Cleavage parallel to the planes of the primary. Fracture uneven and conchoidal. Lustre resinous. Translucent, or translucent on the edges. Brittle. Hardness 3.0. Specific gravity from 6.69 to 6.76. Before the blowpipe on charcoal, it melts, and is absorbed by it, leaving behind some globules of reduced lead. Dissolves in concentrated muriatic acid, under separation of chloride of lead, producing a green solution, which, on being somewhat diluted and stirred with an iron spatula, acquires a blue colour (*Kobel*).

Composition. Oxide of lead 60.86, molybdic acid 39.14 (*Berzelius*). The formula is $Pb.MoO_3$.

Geological Situation. It is said to occur in compact limestone at Bleiberg at Carinthia, and also in France and Saxony.

LOCALITIES.

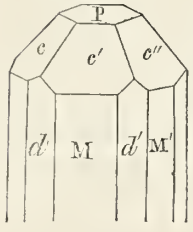
The only locality that has been credited to this State, is the Ancram mine in Columbia county, where, if the yellow lead ore does occur, it is associated with galena. It must, however, be of rare occurrence.

It has been found in small quantities at the Perkiomen lead mine in Pennsylvania, where it is associated with other salts of lead. It occurs in small quadrangular tables with bevelled edges, or with truncated angles. The same mineral, in the form of small tabular crystals of a dark wax-yellow, attached to crystallized quartz, also occurs at the Southampton lead mine in Massachusetts.

PYROMORPHITE.

Plomb Phosphaté. *Haüy.* — Phosphate of Lead. *Cleaveland* and *Phillips.* — Rhombohedral Lead-Spar. *Jameson.* — Rhomboedrischer Blei-Baryt. *Mohs.* — Pyromorphite. *Beudant* and *Shepard.*

Fig. 499.



Description. Colour usually green or brown, sometimes yellow and white. Streak white. It occurs regularly crystallized; also botryoidal, reniform and massive. Primary form a regular six-sided prism. Fig. 499 is a secondary form. M on M′ 120°; P on M or M′ 90°; M or M′ on d' 150°; M on c' or M′ on c'' 131° 45′; P on c or c' 138° 30′; c' on c or c'' 110° 5′ (*Phillips*). Cleavage parallel with M, and also with c. Fracture imperfectly conchoidal and dull. From translucent to translucent on the edges. Hardness 3.5 to 4.0. Specific gravity 6.90 to 7.30. Before the blowpipe on charcoal, it melts in the outer flame into a globule, which crystallizes on cooling, and becomes brown; in the reducing flame, the globule appears bluish, is luminous while hot, and on cooling, crystallizes with large facets of a lighter colour, having somewhat the aspect of mother-of-pearl. It is soluble in nitric acid; and when a bar of zinc is introduced into the solution, blades of metallic lead are deposited on it.

Composition. Oxide of lead 78.50, phosphoric acid 19.73, muriatic acid 1.65 (*Klaproth*).

Geological Situation. It occurs in veins in primitive and transition rocks, associated with galena and other ores of lead and of copper.

LOCALITIES.

Fine specimens of pyromorphite have been found at a mine about a mile south of Sing-Sing in Westchester county, where it was associated with galena, anglesite, malachite and copper pyrites.*

The same mineral has also been found at the Perkiomen lead mine in Pennsylvania, and at a lead mine in Lenox, Massachusetts.

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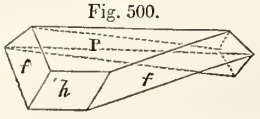
* *Annals of the Lyceum of Natural History of New-York.* IV. 77.

VAUQUELINITE.

[In honour of the celebrated French chemist, VAUQUELIN.]

Cupreous Chromate of Lead. *Cleaveland.* — Vauquelinite. *Phillips*, *Shepard* and *Beudant.* — Cupreo-Chromate of Lead. *Thomson.* — Hemiprismatischer Melanochlor-Malachit. *Mohs.*

Fig. 500.



DESCRIPTION. Colour dark green, approaching olive green. Streak siskin-green or brownish. It occurs regularly crystallized, and also massive. The crystals are small. The primary form is supposed to be an oblique rhombic prism. Dr. Thomson says it is a rhomboid, having nearly the same angles as chabazite. Fracture uneven. They are often compound, as in the accompanying Fig. 500. P on P′ over the summit, 134° 30′; P on *h* 149° (*Phillips*). Lustre faintly resinous, or dull. Faintly translucent or opaque. Hardness from 2.5 to 3.0. Specific gravity 5.80 (*Phillips*); from 6.80 to 7.20 (*Beudant*). Alone before the blowpipe upon charcoal, it melts with much frothing, and yields a few small grains of lead. It is soluble in nitric acid. The solution exhibits the characters of chromic acid, and causes a deposit of metallic copper upon a bar of iron, and also blades of lead upon a bar of zinc. The solution of vanadiate of lead gives a copious white precipitate with nitrate of silver, which is not the case with vauquelinite.

COMPOSITION. Chromic acid 28.33, protoxide of lead 60.87, oxide of copper 10.80 (*Berzelius*). It appears to be a compound of the subchromate of lead and the chromate of copper. Formula $2PbO.CrO_3 + CuO.CrO_3$.

GEOLOGICAL SITUATION. This mineral was first found associated with the chromate of lead from Siberia, where it occurs on quartz. It has also been obtained at Pont Gibaud in the Puy de Dome, and is said to accompany the chromate of lead from Brazil.

LOCALITY.

The only known locality of this mineral in the United States, is a mile south of Sing-Sing in Westchester county, where, as we are informed by Dr. Torrey, a specimen was some years since obtained. It was in the form of small mammillary concretions, and also in a granular and sub-pulverulent form. Colour green and brownish green. Lustre resinous. Brittle. Powder greenish yellow. Before the blowpipe, it grows darker and decrepitates, but preserves its green colour; with borax, it forms a fine green bead.*

Dr. Torrey states that the Sing-Sing mineral agrees in every respect with specimens of vauquelinite from Siberia.

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* Torrey. *Annals of the Lyceum of Natural History of New-York.* IV. 76.

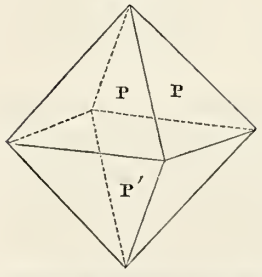
ORDER V. BISMUTH.

1. Native Bismuth.

NATIVE BISMUTH.

Bismuth Natif. *Haüy.* — Native Bismuth. *Cleaveland, Phillips, Thomson* and *Shepard.* — Bismuth. *Beudant.* — Octahedral Bismuth. *Jameson.* — Octaedrisches Wismuth. *Mohs.*

Fig. 501.



Description. Colour silver-white with a tint of red; liable to tarnish. It occurs regularly crystallized; also massive, disseminated, and in leaves having a feathery surface. Primary form the regular octahedron, Fig. 501. Cleavage parallel with the planes of the primary. Lustre metallic. Soft. Sectile. Opaque. Hardness from 2.0 to 2.5. Specific gravity 9.74. Very fusible by the blowpipe, giving a yellow oxide, which is deposited on the charcoal. Soluble in nitric acid, with the disengagement of nitrous acid vapours. When the solution is diluted, a white curdy precipitate falls. In a glass tube it gives almost no smoke, and the metal becomes covered with a fused oxide of a dark brown colour, which on cooling becomes yellow. By this reäction, it is distinguished from native antimony and tellurium (*Von Kobell*).

Composition. This substance, when found in nature, is often mixed with small quantities of sulphur and arsenic.

Geological Situation. It occurs in veins in primitive rocks, as gneiss, mica slate, etc.

LOCALITIES.

Dr. Emmons states that he has found a single specimen of native bismuth in Essex county.* The only other known locality in the United States, is Monroe, Connecticut, where it is found in a bed of quartz with galena, zinc blende, wolfram, etc.

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* *Manual of Mineralogy and Geology.*

ORDER VI. COPPER.

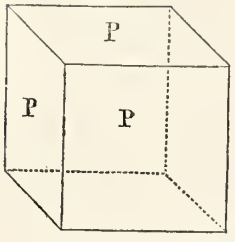
This order includes the following species, viz:

1. Native Copper.
2. Red Copper ore.
3. Vitreous Copper.
4. Copper Pyrites.
5. Green Malachite.
6. Azurite.

NATIVE COPPER.

Cuivre Natif. *Haüy.* — Native Copper. *Cleaveland, Phillips, Shepard* and *Thomson.* — Octahedral Copper. *Jameson.* — Octaedrisches Kupfer. *Mohs.* — Cuivre. *Beudant.*

Fig. 502.



Description. Colour copper-red. Streak shining, but unchanged in colour. It occurs regularly crystallized; also capillary, dendritic, in thin plates and massive. Primary form the cube, Fig. 502; but it is also found in octahedrons and in compound crystals. Cleavage none. Fracture hackly. Lustre metallic. Ductile. Opaque. Hardness from 2.5 to 3.0. Specific gravity from 8.50 to 8.90. Before the blowpipe, it melts easily; and on cooling, is covered with a coat of oxide. It is soluble in nitric acid, to which it gives a green colour. Ammonia added to this solution in sufficient quantity, produces a fine blue transparent solution.

Geological Situation. This mineral occurs in granite, gneiss and mica slate, primitive limestone and serpentine; also in secondary limestone and sandstone.

LOCALITIES.

Washington County. Native copper has been found in this county, but the precise locality is as yet unknown.

Detached masses of native copper of various sizes occur throughout the United States, especially in Michigan, Illinois, Missouri, and the territory of Iowa. Similar masses, sometimes of large size, are found in the soil in various parts of New-Jersey, where thin sheets of nearly pure native copper are frequently observed traversing the red sandstone in the form of narrow veins. These sheets closely resemble the *copper of cementation*, and they are often covered on either side by a coating of the oxide or carbonate of copper.*

Native copper also abounds in the greenstone trap and red sandstone formations of Connecticut and Massachusetts, and in similar situations in Michigan and Iowa.

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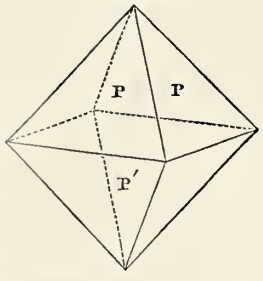
* See a paper by the author, in the *American Journal of Science.* XXXVI. 107.

RED COPPER ORE.

Cuivre Oxidulé. *Haüy.* — Red Oxide of Copper. *Cleaveland, Phillips* and *Thomson.* — Red Copper Ore. *Shepard.* — Octahedral Red Copper Ore. *Jameson.* — Octaedrisches Kupfer Erz. *Mohs.* — Ziguéline. *Beudant.*

Fig. 503.



Description. Colour red of various shades, especially cochineal-red. Streak several shades of brownish red, shining. It occurs regularly crystallized, and also in the form of the octahedron and its modifications; also massive, disseminated, friable or earthy. Primary form the regular octahedron, Fig. 503. Cleavage parallel with the primary planes, but not easily obtained. Fracture uneven. Lustre adamantine, inclining to semi-metallic. Varies from translucent to opaque. Brittle. Hardness from 3.5 to 4.0. Specific gravity from 5.60 to 6.10. Before the blowpipe on charcoal, it is easily reduced into a globule of copper; with borax, it fuses readily into a green glass. It is soluble in nitre and muriatic acids. The solution in muriatic acid gives with caustic potash an ochre-yellow precipitate.

Varieties. *Capillary Red Copper Ore.* This differs chiefly in being made up of extremely slender and elongated crystals, which sometimes appear reticulated, or even fibrous.

Compact Red Copper Ore. Of a brick-red or brownish-red colour, and commonly with an earthy fracture, sometimes glistening. It generally contains oxide of iron.

Composition. Copper 85.50, oxygen 11.50 (*Chenevix*). Formula Cu_2O.

Geological Situation. It occurs in veins, beds and smaller masses, in primitive, transition and secondary rocks, and is associated with other ores of copper and iron.

LOCALITIES.

According to Mr. Mather, this mineral is found in thin seams associated with green carbonate of copper, in the trap rocks two miles from Ladenton in the county of Rockland.*

The red copper ore, occurs imperfectly crystallized and massive, at the Schuyler, Bridgewater and Flemington copper mines in New-Jersey. Some of the specimens have a lead-grey colour, and a high metallic lustre; while others vary in colour from purple to brick-red, and have a compact structure and an earthy fracture. The powder of all of them, however, is reddish. It is also found in thin veins, sometimes associated with native copper, in the red shale near the city of New-Brunswick in the same State.

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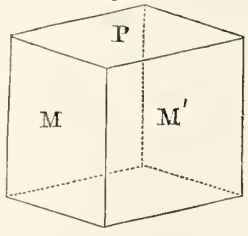
* *New-York Geological Reports*, 1839.

VITREOUS COPPER.

Cuivre Sulfuré. *Haüy.* — Sulphuret of Copper. *Cleaveland* and *Phillips.* — Disulphuret of Copper. *Thomson.* — Vitreous Copper. *Shepard.* — Prismatic Copper Glance. *Jameson.* — Prismatischer Kupfer-Glanz. *Mohs.* — Chalkosine. *Beudant.*

Fig. 504.



Description. Colour blackish lead-grey. Streak similar. It occurs regularly crystallized; also in granular concretions and massive. Primary form a right rhombic prism. Fig. 504. M on M′ 119° 35′. It is often found in regular six-sided prisms. (According to some authors, the primary is a cube.) Cleavage very imperfect. Fracture conchoidal and uneven. Lustre metallic. Opaque. Sectile. Hardness from 2.5 to 3.0. Specific gravity from 5.69 to 5.80. Before the blowpipe alone, fusible with sputtering; and with carbonate of soda, gives grains of copper. Soluble in hot nitric acid, leaving the sulphur unacted on. When the solution is treated with excess of ammonia, it becomes of a fine blue colour. The copper is also deposited upon a clean plate of iron.

Composition. *Specimen from Siberia* — Copper 78.50, sulphur 18.50, iron 2.25 (*Klaproth*).

Specimen from Cornwall — Copper 77.16, sulphur 22.16, iron 1.45 (*Thomson*). Formula Cu_2S.

Geological Situation. This mineral occurs in veins and beds, accompanying other ores of copper.

LOCALITIES.

Columbia County. Vitreous copper, associated with copper pyrites, has been found in the veins of galena which occur in the town of Canaan. It has also been observed on the farm of John F. Catlin, of Austerlitz, in a vein of white quartz, passing through limestone; also on the mountain east of Green river. It is only found massive.

Dutchess County. On the farm of Judge Bockee, in the town of Northeast, this mineral has been found with similar associates to those just noticed.

Mr. Mather informs us that small quantities of the black sulphuret of copper, galena, blende, and the green and blue carbonates of copper, are extensively diffused in a stratum of calcareous conglomerate or breccia, in various parts of Greene, Ulster, Sullivan and Delaware counties, but the stratum is nowhere more than eighteen inches in thickness. These minerals, although frequently observed, do not, however, appear to exist in quantities sufficient to give them any importance in an economical point of view.*

Vitreous copper is found at the copper mines in New-Jersey and Connecticut.

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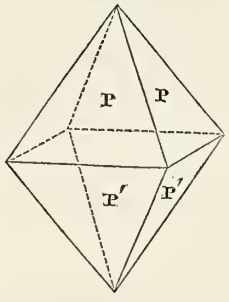
* Mather. *New-York Geological Reports*, 1340.

COPPER PYRITES.

Cuivre Pyriteux. *Haüy.* — Pyritous Copper. *Cleaveland.* — Copper Pyrites. *Phillips* and *Thomson.* — Yellow Copper Pyrites. *Shepard.* — Pyramidal Copper Pyrites. *Jameson.* — Pyramidaler Kupfer-Kies. *Mohs.* — Chalkopyrite. *Beudant.*

Description. Colour brass-yellow, sometimes iridescent. Streak greenish black and feebly shining. It occurs regularly crystallized, massive and disseminated. The primary form is the octahedron with a square base. Fig. 505. P on P′ 125° 30′; P on P and P′ on P′ 102° 30′. But the usual shape of the crystal is a tetrahedron, with the angles replaced by small triangular planes. Fracture uneven or conchoidal. Lustre metallic. Brittle. Rather sectile. Hardness from 3.5 to 4.0. Specific gravity from 4.15 to 4.30. Fusible before the blowpipe into globules, which become magnetic if the blast is continued for some time; with borax, it yields a globule of copper. It is soluble in nitric acid, leaving sulphur. The solution assumes a blue colour upon the addition of a sufficient quantity of ammonia, and gives an abundant precipitate of the red oxide of iron.

Fig. 505.



Composition. *Specimen from Furstenberg* — Copper 33.12, iron 30.00, sulphur 36.52, silica 0.39 (*Rose*).

Specimen from Allevar — Copper 31.10, iron 31.50, sulphur 36.30 (*Berthier*). According to Beudant, the formula is Cu_2S+FeS.

Geological Situation. This mineral is found in veins, in beds and large masses, in primitive, transition and secondary rocks. In this State, it is almost always associated with galena, and is found in the primary rocks of the northern counties, in the sandstone of the Shawangunk mountains, and in the limestones of the west.

LOCALITIES.

Columbia County. Copper pyrites, of a fine brass-yellow colour, is usually associated in greater or less quantities with the galena and zinc blende found in various parts of this county. The best specimens that I have seen are from the Ancram lead mine, where the copper pyrites occurs in masses of considerable size, and has the beautiful blue tarnish which may be mistaken for the blue carbonate of copper. It is here as elsewhere intermixed with galena and zinc blende, and is often associated with quartz and sulphate of barytes.

Dutchess County. As the veins of galena which occur in Columbia usually extend into this county, it may be inferred that the copper pyrites is also found here. There are hence a number of localities, and among these may be mentioned that on the farm of Judge Bockee, where it is associated with the blue and green carbonate of copper, as well as with galena and zinc blende. The same mineral is also found in small quantities, with similar associates, in the town of Amenia.

Erie County. According to Mr. Vanuxem, minute quantities of copper pyrites are found at Black-Rock, and elsewhere in this county. By decomposition, it gives rise to stains of the green carbonate of copper.

Herkimer County. Near Salisbury corners, the excavations in the calciferous sandstone have furnished small specimens of copper pyrites, with those of iron pyrites, zinc blende and galena.* It is almost impossible, however, to obtain specimens at the present time.

Jefferson County. Minute specimens of this ore of copper were, a few years since, found on the banks of Muscolunge lake in the town of Alexandria.

Niagara County. Small particles of copper pyrites and green carbonate of copper occur in the grey band at Lewiston;† and it is also said to have been found in Oneida county.

Orange County. Copper pyrites is found in small quantities, associated with the arsenical minerals which occur near the village of Edenville. It is also found at the O'Neil iron mine in the town of Monroe.

Putnam County. In the gneiss rock at the Phillips iron mine, eight miles northeast of Coldspring landing, small masses of pyritous and green carbonate of copper are occasionally found with iron pyrites.

St. Lawrence County. This mineral occurs at several localities in this county. One of these is about five miles from Rossie, beyond De Long's mill. Several tons were raised at this mine in searching for a bed of iron ore, and it has been thought to be a rich vein. Another occurs near Canton, where the ore is found in thin beds, apparently between the layers of limestone, nearly in a horizontal direction. These ores yield about twelve per cent. of metallic copper.‡

Fig. 506.

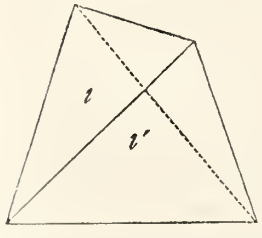
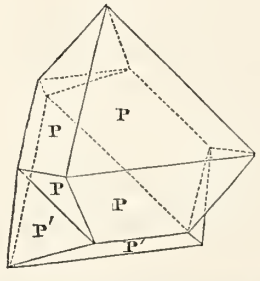


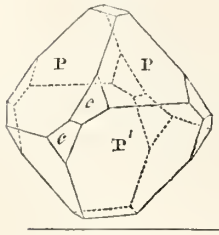
Fig. 507.



At the Rossie lead mine, specimens of crystallized copper pyrites have been found in the galena. They exhibit trihedral terminations, a little rounded like some crystals of calcareous spar. Also the forms represented in Figs. 506 and 507, of which the latter is a twin, composed of about equal parts of an octahedron, one half of which is turned half round. P on P′ 125° 30′; *l* on *l*′ 71° 10′.

Sullivan County. This mineral occurs in considerable abundance, associated with galena and zinc blende, at the mine near Wurtzborough. It is found both crystallized and massive. It has a beautiful tarnish, and is sometimes coated with green carbonate of copper. The crystals are in the form of the octahedron with the modification represented in Fig. 508, but they are seldom perfect. P on *c* 140° 30′. The gangue is quartz, which is both massive and crystallized.

Fig. 508.



* Vanuxem. *New-York Geological Reports*, 1838. † Hall. *Ibid.* 1838. ‡ Emmons. *Ibid.* 1838.

Ulster County. This mineral is occasionally found associated with galena, zinc blende, etc. in quartz, at the Ellenville and Red-bridge mines.

Westchester County. Copper pyrites has been found in the white limestone in various parts of this county, but the localities are of little importance. Good specimens were formerly obtained in the immediate vicinity of the prison at Sing-Sing, where it is said that a shaft was sunk, previously to the American Revolution, by a British officer. Native silver, copper and lead ore, were the reputed products of the mine; but the information which we possess on the subject is quite vague. This mine was drained a few years since, but not worked. The rock is the dolomitic limestone, containing pyroxene and some magnetic pyrites.

Rockland County. This mineral is sometimes sparingly disseminated in the trap at Piermont.

Warren County. Imperfect crystals have been found in white limestone in the town of Chester.

GREEN MALACHITE.

[From the Greek μαλάχη, *a mallow;* because of its colour.]

Cuivre Carbonaté Verte. *Haüy.* — Green Carbonate of Copper. *Cleaveland* and *Phillips.* — Green Malachite. *Shepard.* — Hydrous Dicarbonate of Copper. *Thomson.* — Hemiprismatic Green Malachite. *Jameson.* — Hemiprismatischer Habronem Malachit. *Mohs.* — Malachite. *Beudant.*

Description. Colour various shades of green. Streak green, but paler. It occurs regularly crystallized, compact and earthy; also in slender fibres, which are fasciculated or stellated. Primary form an oblique rhombic prism. M on M′ 107° 20′; P on M or M′ 112° 52′ (*Brooke*). According to Phillips, the primary is a right oblique angled prism, M on M′ 123° 35′; and Beudant makes it a right rhombic prism, with the angles 103° and 77°. The crystals are very minute, and usually compound. Cleavage perfect parallel to the planes P and M; difficult parallel to P (*Phillips*). Fracture uneven, conchoidal and even. Lustre adamantine, inclining to vitreous, sometimes silky. Varies from translucent to opaque. Brittle. Hardness from 3.5 to 4.0. Specific gravity from 3.50 to 4.00. Before the blowpipe, it becomes black after decrepitation, and is partly converted into a black scoria; with borax, it yields a bead of copper, and colours the flux green. From its solution, metallic copper is precipitated by a clean plate of iron.

Composition. Copper 56.00, oxygen 14.00, carbonic acid 21.25, water 8.75 (*Vauquelin*). Formula $2CuO.CO_2+Aq$.

Geological Situation. This mineral occurs associated with copper pyrites and other ores of copper, in veins which traverse primitive, transition and secondary rocks.

LOCALITIES.

Green malachite has heretofore been found in this State only as an incrustation. Thus it occurs on copper pyrites in the counties of Columbia, Dutchess and Sullivan, in the veins of galena. In the same form, it has also been observed in the limestone of Erie county; in the grey band at Lewiston in Niagara; in the trap in Rockland, and on magnetic iron ore at the Phillips mine in Putnam.

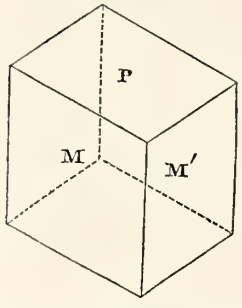
This mineral, in small quantities, having the fibrous character, and associated with the red oxide and sulphuret of copper, occurs at the copper mines of New-Jersey, and at the Perkiomen lead mine in Pennsylvania. The United States, however, has not hitherto afforded very fine specimens.

AZURITE.

[In allusion to its colour.]

Cuivre Carbonaté Bleu. *Haüy.* — Blue Carbonate of Copper. *Cleaveland* and *Phillips.* — Blue Malachite. *Shepard.* — Prismatic Blue Malachite. — *Jameson.* — Hemiprismatischer Lazur-Malachit. *Mohs.* — Hydrocarbonate of Copper. *Thomson.* — Azurite. *Beudant.*

Fig. 509.



Description. Colour azure or berlin-blue, sometimes passing into blackish blue. Streak similar but lighter. It occurs regularly crystallized in concretions which are scopiform and stellular, radiated, and also curved lamellar; massive, globular, stalactitic and cellular. Primary form an oblique rhombic prism. Fig. 509. M on M′ 98° 50′; P on M or M′ 91° 30′ (*Phillips*). Cleavage perfect, parallel to M and M′; difficult parallel to P. Fracture conchoidal. Lustre vitreous or vitreo-resinous. Transparent to translucent on the edges. Brittle. Hardness from 3.5 to 4.0. Specific gravity from 3.50 to 3.80. Before the blowpipe, it blackens, decrepitates, and at length fuses. Colours borax green. Dissolves in nitric acid with effervescence. The solution produces a blue colour with ammonia, and forms a coating of copper on a clean plate of iron.

Composition. Copper 56.00, oxygen 12.50, carbonic acid 25.00, water 6.50 (*Vauquelin*). Formula $3CuO.2CO_2+Aq$.

Geological Situation. It occurs in beds and veins in rocks of various ages, usually associated with other ores of copper, galena, zinc blende, etc.

LOCALITIES.

Incrustations of azurite are found with copper pyrites at Sing-Sing in Westchester county; and the same mineral is also occasionally observed, forming thin scales on the limestone in the same vicinity

This mineral is frequently found in imperfect crystals, coating the strata of red shale, in the vicinity of New-Brunswick in New-Jersey. These crystals effervesce, and are entirely dissolved, in nitric acid. It appears in this case to be the result of precipitation from an aqueous solution. The oxide of copper is disseminated through the rocks in the vicinity, and the carbonate is found most abundant near the bed of a ravine. Water charged with carbonic acid, dissolves a portion of this oxide; and whenever circumstances favour the escape of the excess of acid, the salt is deposited. Blue malachite is also found in Pennsylvania at the Perkiomen lead mine, where it occurs in small crystals.

ORDER VII. TITANIUM.

1. Native Titanium.
2. Anatase.
3. Rutile.
4. Ilmenite.
5. Sphene.
6. Warwickite.

NATIVE TITANIUM.

Native Titanium. *Thomson.*

Description. Colour copper-red. It usually occurs in the form of small cubes with smooth surfaces. Lustre splendent and metallic. Opaque. Hardness 7.5. Specific gravity 5.30. Infusible by the blowpipe. Not sensibly acted upon by acids. The crystals may be oxidized when heated with a mixture of borax and carbonate of soda. They are good conductors of electricity.

LOCALITIES.

This metal was first found in a state of purity in the slag of Merthyr Tydvil furnaces, in South Wales, by Dr. Wollaston, in 1822.

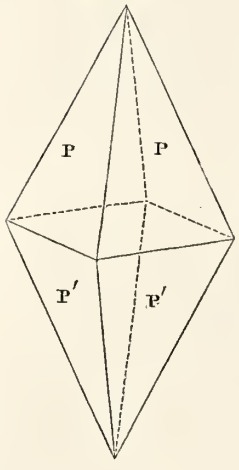
Dr. Emmons found the same metal in the hearth-stone of an iron furnace in St. Lawrence county; and I have obtained specimens occasionally in the form of minute cubes, in the slag of the Greenwood furnace in Orange county. It is undoubtedly produced by the decomposition of some of the titaniates combined with the ores of iron.

ANATASE.

[From the Greek, signifying *elevated*; in allusion to the height of the pyramids of the octahedral crystals.]

Anatase. *Hauy, Beudant, Phillips* and *Shepard.* — Octaedral Oxide of Titanium. *Cleaveland.* — Protoxide of Titanium. *Thomson.* — Pyramidal Titanium. *Jameson.* — Pyramidales Titan-Erz. *Mohs.*

Fig. 510.



Description. Colour blue and brown of various shades; by transmitted light, it is grcenish yellow. Streak white. It occurs regularly crystallized. The primary form is an octahcdron with a square base. Fig. 510. P on P and P′ on P′ 98° 5′; P on P′ 136° 47′. Cleavage parallel to the primary faces, and perpcndicular to the axis. Fracture conchoidal, scarcely observablc. Lustre splcndent and adamantine. Translucent and transparent. Brittle. Hardness from 5.5 to 6.0. Specific gravity from 3.80 to 3.90. Alone before the blowpipe, it is infusible; with soda, it forms a dull yellow globulc, which becomes white on cooling.

Composition. It is supposed to be a pure oxide of titanium. Formula TiO.

Geological Situation. It occurs in small irrcgular veins in primitive rocks, as granite and mica slate, where it accompanies albite, axinite, quartz, etc. It is still a rare mineral.

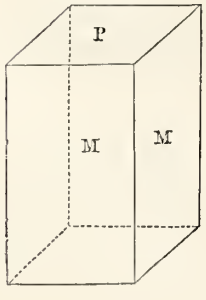
LOCALITY.

There sometimes accompanics the spccimens of native titanium found in the slags of Orange county, a coating of a dark blue or purple colour, which may be the oxide of titanium. Although the quantity heretofore observed is quite too small for a chemical examination, the circumstanees undcr which it is found seem to warrant the opinion which has bcen advanced.

RUTILE.

Titane Oxidé. *Haüy.* — Red Oxide of Titanium. *Cleaveland.* — Rutile. *Phillips, Shepard* and *Beudant.* — Titanic Acid. *Thomson.* — Peritomous Titanium Ore. *Jameson.* — Peritomes Titan-Erz. *Mohs.*

Fig. 511.



Description. Colour red, brown, yellow, and sometimes nearly vclvet-black. Strcak pale brown. It occurs regularly crystallized; also massive, disseminated, in angular grains and flakes. Primary form a right square prism, Fig. 511. In some crystals thc lateral edges are replaced by tangcnt planes; in others, by two planes. The prism is terminated by a four or eight-sided pyramid, and is sometimes geniculated and striated longitudinally. Clcavage pcrfect parallel with M; interrupted parallel with *l* (see Fig 513). Fracture conchoidal. Lustre adamantine, inclining to metallic. Transparcnt to opaque.

Brittle. Hardness from 6.0 to 6.5. Specific gravity from 4.18 to 4.40. Alone before the blowpipe, it is not altered. It dissolves in borax, forming a hyacinth red bead.

Varieties. *Nigrine.* This name is applied to the dark brown or black opaque mineral; while that of *Rutile* is given to the variety which has usually a blood-red colour.

Composition. Rutile is composed of titanium 56.05, and oxygen 33.35; nigrine contains oxide of titanium 84.00, oxide of iron 14.00, oxide of manganese 2.00. It has been supposed by some that rutile also contains a portion of oxide of iron, and that both varieties are titaniates of iron. The formula of rutile when pure, is TiO_2.

Geological Situation. This mineral usually occurs in granite and quartz rock. In this State, it has also been found in primary limestone.

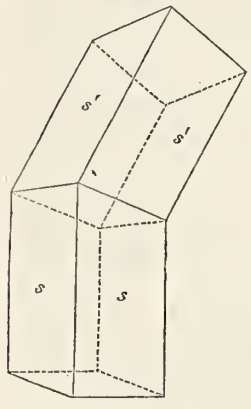
LOCALITIES.

Essex County. According to Dr. Emmons, rutile occurs in the white limestone of this and the adjoining county of Warren.

Montgomery County. Mr. Mather has found minute crystals of this mineral in the calcareous spar near Spraker's basin.

New-York County. Several forms of crystallized rutile have been found in the veins of quartz, feldspar and mica, which traverse the primitive limestone near Kingsbridge. Several varieties have been described by Dr. Bruce, viz: Small, four-sided, prismatic, nearly acicular semi-transparent crystals of a dark blood-red colour, in a granitic aggregate of feldspar, bluish quartz and brown mica. Also the *géniculé-ternaire* of Haüy, Fig. 512, consisting of two four-sided prisms, so connected at their base as to form a jointed crystal; dark red and semi-transparent. *s* on *s* 126° 52′.

Fig. 512.

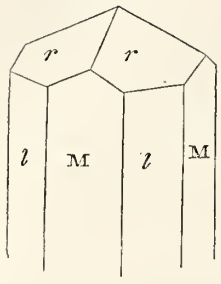


Large amorphous masses of blood-red oxide of titanium were also found on white feldspar with brown mica; and the same mineral, of a light red colour, with similar associates.*

Orange County. Several localites of rutile occur in this county. One of these is about a mile north of the village of Edenville, where it is met with in limestone bowlders, associated with the variety of hornblende called *pargasite.*

* Bruce. *American Mineralogical Journal,* 235.

Fig. 513.



Another locality occurs about two miles east of the village of Warwick, where rutile is found in granite, associated with zircon and iron pyrites. It is in the form of crystals, which are often well defined. They are eight-sided prisms with four terminal planes, Fig. 513. The colours are brownish and iron-black. M on l 135° 5′; l on r 132° 20′; r on r 123° 15′.

A mile east of the village of Amity, it occurs in dark brown, reddish brown and pale red crystals, penetrating quartz, and associated with brown tourmaline. They are long, slender and striated prisms without terminations, and short eight-sided prisms terminated by three planes.

Two miles west of Amity is another locality, where there are found crystals of a black, steel-grey or reddish brown colour, in the form of six or eight-sided prisms variously terminated, and associated with crystallized hornblende, spinelle and corundum.

The same mineral also occurs, according to Dr. Horton, two miles southwest of the village of Amity, in dark-blue eight-sided prisms with four terminal planes, and is associated with red spinelle, chondrodite, hornblende, mica, clintonite, etc., in white limestone.

Fig. 514.

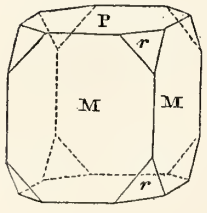
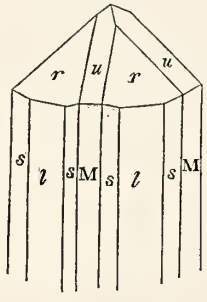


Fig. 515.



Again it is found near the village of Warwick, in long slender, black, striated prisms, penetrating quartz, in geodes in blue limestone. The forms represented in Figs. 514 and 515, have been obtained in this town. M on l 135° 5′; M on s 161° 40′; l on s 153° 33′; r on r 123° 15′; r on u 151° 42′.

St. Lawrence County. A small crystal, of a red colour and high lustre, has been found in quartz, near Gouverneur. It has the form of a right square prism, slightly bent and striated.

Small steel-grey crystals of rutile, in six-sided prisms rounded at the extremities, were formerly found by Mr. G. Chilton in an insulated mass of bluish quartz near the Schuyler copper mine in New-Jersey.* It also occurs in white limestone at Newton in the same State.

The locality which affords the greatest quantity of this mineral, is a ledge of chlorite slate at Windsor, Massachusetts. It also occurs at Monroe and Huntington in Connecticut, and in the counties of Hampshire, Berkshire and Franklin, in Massachusetts (*Shepard*).

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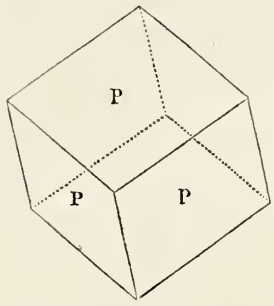
* *American Mineralogical Journal*, 236.

ILMENITE.

[From the place where it was first found, near Lake *Ilmen*, in Siberia.]

Ilmenite. *Phillips* and *Thomson*. — Axotomes Eisen-Erz. *Mohs*. — Aechynite (app. to Polymignite). *Beudant?* — Mengit. *Mohs*, App.? — Crichtonite. *Shepard*.

Fig 516.



Description. Colour brownish or iron-black. Streak black. It occurs crystallized and massive. The form of the crystals is the same as that of specular iron. Primary a rhombohedron. Fig. 516. P on P 85° 59′. Cleavage perfect parallel to *a* (see Fig. 517). Fracture conchoidal. Lustre imperfect metallic. Translucent. Brittle. Hardness from 5.0 to 5.7. Specific gravity from 4.40 to 4.80; 4.77 to 4.81 (*Thomson*). It slightly affects the magnetic needle. Before the blowpipe, thin edges are rounded, but it does not fuse; with fluxes, it behaves like oxide of iron. When in fine powder, it is soluble in hot concentrated muriatic acid.

Composition. *Specimen from the Ural mountains* — Titanic acid 46.67, peroxide of iron 11.71, protoxide of iron 35.37, protoxide of manganese 2.39, magnesia 0.60, lime 0.25, oxide of chromium 0.38, silica 2.80 (*Mosander*). According to Kane, the formula is $FeO.TiO_2$.

Geological Situation. It occurs in granite, serpentine and white limestone, and is sometimes associated with rutile, and at others with magnetic iron ore.

There is still some confusion in regard to this mineral, arising in part from the difficulty which attends the accurate analysis of the compounds of titanium, and in part also from the fact that minerals which are nearly identical in composition, having been found at different localities, have received different names. No positive opinion, however, can at present be expressed on this subject. It is believed that the *Crichtonite* of Shepard is identical with *Ilmenite;* and perhaps the same is true of the *Crichtonite* of Count Bournon, and of some of the other minerals in which titanic acid is combined with the oxides of iron.

LOCALITIES.

The most remarkable localities of ilmenite are in the towns of Warwick and Monroe in Orange county. One of these is about a mile south of the village of Amity. It occurs here in crystals of various sizes, sometimes an inch in diameter, imbedded in a dark coloured serpentine. The forms are similar to those of specular iron ore, for which this mineral was mistaken. It may, however, be distingushed by its colour, streak, and diminished specific

Fig. 517.

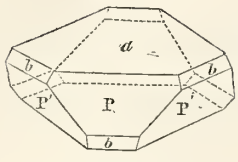
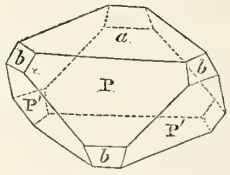


Fig. 518.



gravity. Figs. 517 and 518. P on *a* about 128° ; P on *b* or P′ on *b* 123° 14′.

The same mineral, in crystals similar to those just noticed, is found two miles south of the village of Amity, associated with crystallized serpentine, etc.

There is another locality four miles west of the village of Edenville in the same town, where ilmenite occurs in crystals and grains. It does not act upon the magnet in the slightest degree. It is associated with spinelle, chondrodite, hornblende and copper mica in white limestone. Dr. Horton states that a crystal was some years since found at this locality, two inches in length.

Some interesting localities of this mineral also occur in the town of Monroe in this county. One of these is the Stirling iron mine, where it is found in small but well defined crystals, the larger ones usually having rounded angles. The colour is not so black as that of the specimens from the neighbourhood of Amity. It slightly affects the needle. It is associated with hornblende, feldspar, and the magnetic iron ore.

The same mineral is also found near Greenwood furnace, with spinelle and chondrodite; and at the Crossway mine, in crystals and grains with hornblende, cleavable pyroxene and magnetic iron ore.

Ilmenite, in rounded and imperfect crystals of an iron black colour, is found in quartz, associated with reddish brown zircon and magnetic iron ore, on Deer hill in the town of Cornwall.

Prof. Shepard notices the occurrence of what he denominates *Crichtonite*, in broad laminated imperfectly hexagonal masses at Washington, Connecticut, and likewise in the eastern part of the same State.

Many of our magnetic and specular iron ores contain variable proportions of titanic acid, as is proved by analysis, and by the fact that metallic titanium often results from their reduction. One of the most remarkable specimens of this kind is from Alexandria in Jefferson county. The term *titaniferous iron ore*, applied to certain compounds of titanic acid and the oxides of iron, is still very vaguely employed. It is more than probable that two or more distinct minerals are now included under it.

SPHENE.

[From the Greek σφην, *a wedge;* probably in reference to the form of some of its crystals.]

Titane Siliceo-Calcaire. *Haüy.* — Silico-Calcareous Oxide of Titanium. *Cleaveland.* — Sphene. *Phillips, Thomson, Shepard* and *Beudant.* — Hemiprismatic Titanium-Ore. *Jameson.* — Prismatisches Titan-Erz. *Mohs.*

Fig. 519.

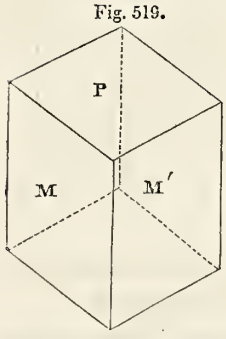
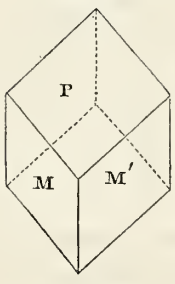


Fig. 520.



Description. Colour yellow, brown, green and grey, usually dull. Streak greyish white. It occurs regularly crystallized; also massive, in granular and lamellar distinct concretions. Primary form an oblique rhombic prism. Fig. 519. M on M′ 133° 30′; P on M 121° 50′ (*Phillips* and *Beudant*). Fig. 520. M on M′ 76° 2′; M or M′ on P 93° 1′ (*G. Rose* and *Thomson*). Cleavage parallel to the faces of the primary prism, but not distinct. Fracture imperfect conchoidal. Lustre adamantine, sometimes inclining to resinous. Varies from transparent to opaque. Hardness from 5.0 to 5.5. Specific gravity from 3.49 to 3.60. Before the blowpipe, it fuses with difficulty into a dark coloured enamel; with borax, it affords a yellowish green diaphanous glass. It is soluble in heated muriatic or nitric acid, leaving a siliceous residue. By boiling, the titanic acid is precipitated.

Composition. Oxide of titanium 33.00, silica 35.00, lime 33.00, trace of manganese (*Klaproth*). Titanic acid 48.00, silica 33.00, lime 19.00 (*Rose*). The latter results, it will be observed, differ considerably from those obtained by Klaproth and Cordier.

Geological Situation. This mineral occurs in small nodules or crystals in granite, gneiss, and primitive limestone. In this State, it is most frequently found in the latter rock.

Essex County. Sphene was first noticed as a New-York mineral, in the vicinity of Ticonderoga, by the late Col. Gibbs.* The crystals were described as having a yellowish grey colour, and the form of rhomboidal prisms terminated by dihedral summits. They were imbedded in an aggregate of white granular and lamellar feldspar.

Dr. Bruce has also described, as from the vicinity of Lake George, probably from Rogers' rock, large clove-brown crystals in form similar to that of Fig. 521, imbedded in a rock composed of hornblende, feldspar and foliated graphite.

At Rogers' rock, crystallized sphene is very abundant, and is associated with pyroxene and graphite. The crystals are of various sizes, have a brown colour, and exhibit the forms represented in Figs. 522, 523 and 524. M or M′ on *a* 139° 30′; P on e_2 158° 18′; *c* on d_1 146° 44′; *c* on *e* 145° 18′; e_2 on e_2 136° 50′ (*Phillips*).

American Mineralogical Journal, 239.

Fig. 521.

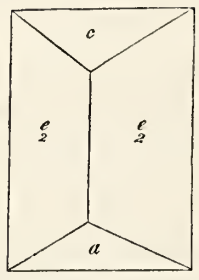


Fig. 522.

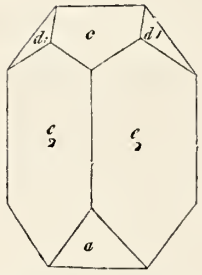


Fig. 523.

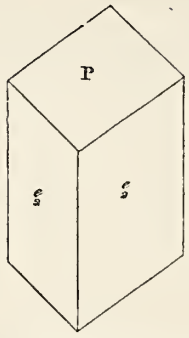
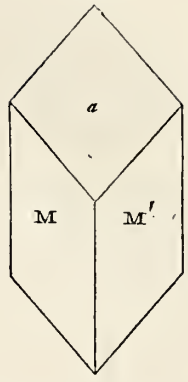
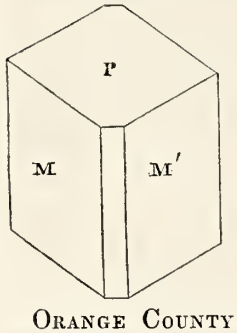


Fig. 524.



The same mineral, in large but imperfect crystals, occurs near Kirby's graphite mine, four miles northwest from Ticonderoga, where it is associated with pyroxene and scapolite.

Fig. 525.

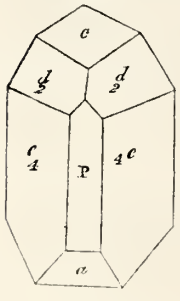


Lewis County. Near Natural bridge in the town of Diana, sphene occurs in crystals of a dark chocolate-brown colour, with pyroxene, scapolite and feldspar. The crystals are usually small, but often very perfect, and have the form of the primary (Fig. 519); also that represented in Fig. 525, and several other modifications, which are supposed to belong to a distinct species (see Appendix to Sphene.)

New-York County. Small brilliant crystals, in form similar to Fig. 521, of a light dove colour, have been found imbedded in the primitive limestone at Kingsbridge.*

Orange County. There are several localities of sphene in this county. One of the most interesting is near Duck-cedar pond in the town of Monroe, where it occurs in great abundance, and in crystals of large size, in primitive limestone.

Fig. 526.



This mineral also occurs near the outlet of the Two ponds in the town of Monroe, where it is associated with pyroxene, scapolite and zircon in white limestone. The crystals have a dark chocolate-brown colour, and are often of considerable size.

The forms observed in this town are the primary (Fig. 519); Figs. 521, 522, 523, 524, 525; and Fig. 526, *spinthère* of Haüy. P on *a* 159° 44′; P on *c* 140° 52; P on e_4 146° 30′; *c* on e_4 154° 52′; d_2 on d_2 136°; e_4 on e_4 113° 40′ (*Phillips*).

In the town of Warwick, sphene occurs in rounded grains and imperfect crystals, disseminated through limestone, with hornblende, etc., in

* *American Mineralogical Journal*, 241.

the vicinity of the village of Edenville. The crystals are sometimes nearly two inches in diameter, and often have the surface pitted or striated. The colour is light brown.

Five miles south of the village of Warwick, the same mineral is found in large crystals and crystalline masses, of a greyish brown colour, often inclining to white on the surface. It is associated with zircon, hornblende and iron ore.

Fig. 527.

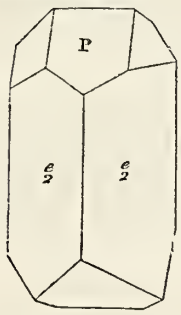
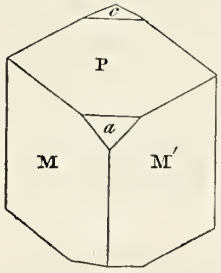


Fig. 528.



At Amity meadow, and a mile south of the village of Amity, crystals of sphene are also found, associated with the minerals for which this region is so noted. The crystals here are usually small, sometimes pitted, and in colour are similar to those just noticed. The forms observed in this town are similar to those represented in Figs. 521 and 526; also to Figs. 527 and 528.

Putnam County. Sphene, massive and beautifully crystallized, was discovered by Dr. Barret at Coldspring landing, in 1822,* during the excavations for the long buildings near the shore on the north side of the village. These crystals are of a light brown colour, and exhibit a brilliant cleavage. This locality has long since been exhausted (see Appendix to this species).

Richmond County. According to Dr. Bruce, fine specimens of sphene were obtained in a rock which was thrown out at the site of Fort Richmond, when the works were first commenced. The crystals were similar in colour and figure to those found at Ticonderoga, and were imbedded in compact opaque feldspar, and in dark bottle-green hornblende.†

St. Lawrence County. At Gouverneur, sphene is met with in small black shining crystals, imbedded in primitive limestone, associated with scapolite, apatite, etc.

About two miles west of Oxbow, on the road to Rossie village, small light coloured crystals are found associated with crystallized hornblende, pyroxene and feldspar. They are not abundant.

Westchester County. This mineral has been found in the vicinity of Peekskill, in an aggregate of feldspar, quartz and hornblende. Near West-Farms, also, it has been met with in very small reddish brown, oblique angled, four-sided prisms, generally bevelled on the obtuse solid angles, in compact feldspar.‡

In Massachusetts, sphene both crystallized and massive, and similar to that from Rogers' rock in Essex county, occurs in the limestone of Bolton, associated with pyroxene and petalite.

In New-Jersey, it is found in semi-transparent yellowish crystals, in white limestone, at Newton; also in wax-yellow crystals, in an aggregate of hornblende and feldspar, at Wantage in Sussex county.

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* *American Journal of Science*, IX. 39. † *American Mineralogical Journal*, 240.

‡ Pierce and Torrey. *Cleaveland's Mineralogy.*

APPENDIX.

It was several years since suggested by Mr. Brooke of London, that some of the minerals which had been commonly ticketed *Sphene*, differed from that species, and should constitute a new one. This supposed new mineral was first found at Phillipstown in Putnam county, by Dr. Joseph Barratt. Since that time it has been found by Dr. A. F. Holmes of Montreal, at Grenville in Upper Canada; and more recently in Lewis county, near Natural bridge. The same mineral, probably, also occurs in various parts of Orange county.

In a recent paper by Prof. Shepard, in which he notices some localities of the above mineral, he proposes for it the name of *Lederite*. This name, however, was previously applied by Messrs. C. T. Jackson and Alger to a supposed new species from Nova-Scotia; and although the latter has been thought to be identical with *Gmelinite*, it will probably retain the name given to it, and thus introduce confusion.

The mineral allied to Sphene has a chocolate brown, light brown or dark clove colour. It occurs regularly crystallized and massive. The primary form is an oblique rhombic prism, whose bases are oblique from an obtuse edge. M on M′ 112° 10′; P on M 115° 30′. Lustre vitreous, inclining to adamantine. Semi-transparent to translucent. Hardness from 5.5 to 5.7. Specific gravity from 3.33 to 3.57. Before the blowpipe, it exhibits the same characters as sphene.*

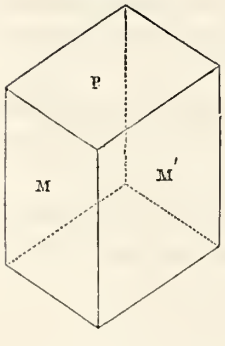
This mineral has not yet been analyzed, and the only known difference between it and sphene is in the crystalline form. It must, therefore, be left to future observation to determine whether it is entitled to the rank of a species.

WARWICKITE.

[From its being found in the town of *Warwick*, Orange county.]

Warwickite. *Shepard* (*Amer. Jour. of Science.* XXXIV. 313).

Fig. 529.



Description. Colour dark hair-brown to iron grey. It occurs regularly crystallized. Primary form an oblique rhombic prism. Fig. 529. M on M′ 93° to 94°. Cleavage parallel with the longer diagonal perfect. The cleavage planes thus obtained are finely striated vertically, and exhibit very distinct oblique cross cleavages. Fracture uneven. Lustre eminently metallic, pearly; of a copper red colour on the perfect cleavage faces; in other directions, only vitreous in moderate degrees. Opaque except in very thin fragments, when it is translucent. Brittle. Hardness from 5.5 to 6.5. Specific gravity, from 3.0 to 3.14. Before the blowpipe on charcoal, it is infusible, but becomes of a lighter colour; with borax, it dissolves

* Shepard. *American Journal of Science*, XL. 357.

with effervescence, affording while hot a yellow semi-opaque glass, which, on cooling, changes to a pale green, and becomes clear. When pulverized, treated with sulphuric acid, and subjected to heat, it gives out fumes which corrode glass.*

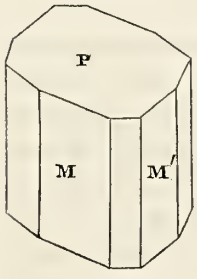
Composition. Titanium 64.71, iron 7.14, yttrium 0.80, fluorine 27.33, aluminum a trace (*Shepard*).

Geological Situation. It has heretofore been found only in white limestone.

LOCALITY.

Orange County. The only known locality of this mineral is two and a half miles southwest of the village of Edenville, where it occurs associated with spinelle, serpentine, chondrodite, mica, etc. In reviewing the measurements of the crystals, they seem to differ considerably from those above given by Shepard. M on M′ from 102° to 105°. One of the secondary forms is represented in Fig. 530, in which the obtuse lateral edges of the primary are truncated, and its acute one bevelled. Its summits are often rounded, and it is quite difficult to measure the inclination of the several planes.

Fig. 530.



However much this mineral may resemble hypersthene and bronzite, in chemical composition it differs remarkably from both these minerals.

It is to be regretted that this name has been given to the present species, as it had previously been appropriated by Dr. Thomson to an entirely different mineral.

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* The preceding description of this mineral is drawn from two papers in regard to it by Prof. C. U. Shepard. *American Journal of Science*, XXXIV. 313; XXXVI. 95.

ORDER VIII. MOLYBDENUM.

This includes only a single species, viz :

1. Molybdenite.

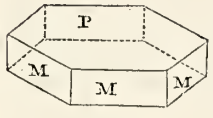
MOLYBDENITE.

[From the Greek μολυβδος, *lead;* because of its resemblance to that metal.]

Molydene Sulfuré. *Haüy.* — Sulphuret of Molybdena. *Cleaveland* and *Phillips.* — Molybdenite. *Shepard.* — Bisulphide of Molybdenum. *Thomson.* — Rhombohedral Molybdena. *Jameson.* — Dirhomboedrischer Eutom-Glanz. *Mohs.* — Molybdenite. *Beudant.*

Description. Colour pure lead-grey. It occurs crystallized in very flat six-sided prisms, which are easily divisible parallel with their terminal planes; also massive, with a lamellar structure. Primary form the regular six-sided prism, Fig. 531. Cleavage perfect parallel with P. Lustre metallic. Opaque. Sectile, approaching to malleable. Thin plates are highly flexible, but not elastic; unctuous to the touch. On porcelain or pottery, it leaves a greenish streak; on paper, traces of a metallic grey colour. Hardness from 1.0 to 1.5. Specific gravity from 4.40 to 4.70. Before the blowpipe, it gives out sulphureous fumes, which are deposited on the charcoal; but it is infusible, and is not reduced. It is soluble with effervescence in nitric acid, leaving a grey residue, which becomes blue when it is brought in a moist state in contact with a plate of zinc. Heated with nitre in a platinum spoon, it deflagrates strongly with flame.

Fig. 531.



It may be distinguished from graphite which it often closely resembles, by the above characters, but especially the difference of its streak on porcelain.

Composition. Molybdenum 60.00, sulphur 40.00 (*Bucholz*). Formula MoS_2.

Geological Situation. This mineral occurs imbedded in granite, gneiss and other primary rocks. It is often associated with quartz.

Uses. It is from this ore that the metal and its compounds are usually prepared.

LOCALITIES.

Molybdenite has not heretofore been found very abundantly in this State. It has, however, been met with in Clinton county; on the island of New-York; and in various parts of the Highlands, as at West-Point, at the Phillips iron mines, etc. It has also been found in irregular plates, associated with iron pyrites, rutile, zircon, etc., in granite, two miles southeast of the village of Warwick in Orange county.

In Massachusetts, this mineral is found at Shutesbury. It also occurs in crystals and large plates at Haddam and the adjoining towns in Connecticut. A large vein has been also found at Westmoreland in Vermont.

ORDER IX. ARSENIC.

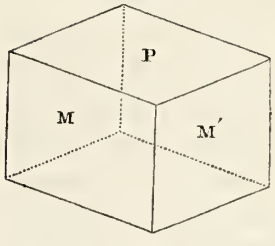
1. Orpiment.

ORPIMENT.

(From the Latin *auripigmentum, paint of gold;* in allusion to its colour, and because it was formerly thought to contain that metal.)

Arsenic Sulfuré Jaune. *Hauy.* — Orpiment. *Cleaveland, Shepard* and *Beudant.* — Sulphuret of Arsenic. *Phillips.* — Sesquisulphide of Arsenic. *Thomson.* — Prismatoidal Sulphur. *Jameson.* — Prismatoidischer Schwefel. *Mohs.*

Fig. 532.



Description. Colour bright lemon-yellow. Streak similar, but paler. It occurs regularly crystallized; also massive, disseminated, reniform, stalactitic, botryoidal, in crusts and efflorescences. The crystals are minute, and the primary form is a right rhombic prism. Fig. 532. M on M′ 100° (*Phillips*). Lustre between adamantine and semi-metallic. Semi-transparent or translucent on the edges. Sectile. Flexible, but not elastic. Hardness from 1.5 to 2.0. Specific gravity from 3.40 to 3.60. Before the blowpipe, on charcoal, it fuses readily, and volatilizes with a strong arsenical smoke. When subjected to heat in a tube, it melts and deposits yellow crystals in the upper part. It is soluble in caustic potash, and muriatic acid precipitates from this solution lemon-yellow flocks.

Composition. Arsenic 61.86, sulphur 38.14 (*Laugier*). Formula AsS_3.

Geological Situation. It occurs in metalliferous veins in primitive rocks, with galena, blende, and other ores of arsenic. At Tajowa in lower Hungary, it is found in blue clay.

Uses. When it occurs in sufficient abundance, it is used with the other ores for obtaining the metal. The same compound, artificially prepared, was formerly much employed as a paint, under the name of *Kings' yellow.*

LOCALITIES.

This mineral, which in its crystalline form is yet very rare, is found in the form of a thin crust or efflorescence, covering the sides of the shaft and timbers of an old mine of arsenical pyrites, four or five miles northwest from the village of Carmel in Putnam county. It only appears where the shaft and timbers have been covered by water, and it is undoubtedly the product of the partial decomposition of the arsenical pyrites, which has here been found in considerable abundance.

ORDER X. CERIUM.

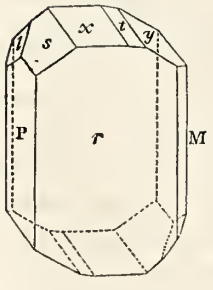
1. Allanite.

ALLANITE.

[In honour of Mr. ALLAN, the Mineralogist, who first noticed it.]

Allanite. *Cleaveland, Phillips, Thomson* and *Shepard.* — Variety of Cerine. *Beudant.* — Anorthitic Melane-Ore. *Jameson.* — Tetartoprismatisches Melan-Erz. *Mohs.*

Fig. 533.



DESCRIPTION. Colour black inclining to green, grey, or brown. Streak greenish or brownish grey. It generally occurs massive, but is sometimes crystallized in oblique four-sided prisms, variously terminated. P on M about 115°. Cleavage perfect parallel to M and *r*, Fig. 533 (from a crystal brought from Greenland.) Fracture conchoidal. Lustre imperfect metallic. Opaque. Brittle. Hardness from 5.5 to 6.0. Specific gravity from 3.20 to 3.60. Before the blowpipe, it melts with intumescence into a brownish or blackish mass; with borax, it melts into a black opaque globule. It gelatinizes when treated with muriatic acid.

COMPOSITION. Protoxide of cerium 21.60, protoxide of iron 15.10, silica 33.02, protoxide of manganese 0.40, alumina 15.23, lime 11.08, water 3.00 (*Stromeyer*).

The *Cerine* and *Orthite* of Berzelius, are supposed to be identical with this species.

GEOLOGICAL SITUATION. Allanite was first found at Alluk, near the southern extremity of Old Greenland. The variety named Orthite occurs in quartz at Finbo, near Fahlun in Sweden; in granite at Skeppsholm; and also at Lindenaes in Norway, and in Greenland.

LOCALITY.

This mineral, still rare, has been found since the commencement of the Survey, in a vein in feldspar and quartz, in the town of Monroe, Orange county. I received a specimen from Dr. Horton, which has the following characters: The mineral is massive, although it has the appearance of being a part of a crystal. Colour brownish-black. Dull on the outside, but the fresh fracture has a resinous or imperfectly metallic lustre. Powder brown. Opaque or feebly translucent on thin edges. Very brittle. Fracture uneven or small conchoidal. Hardness about 6.0. Specific gravity 3.60 to 3.65. It forms a jelly with muriatic acid.

An analysis of this mineral gave the following results, viz:

Protoxide of cerium,	24.90
Silica,	30.50
Alumina,	11.25
Protoxide of iron,	22.27
Lime,	9.87

This approaches very nearly to the composition of the Cerine found at Bastnaes, near Riddarhytta, in Sweden.* The *Cerite* of Hisinger, Thomson and Phillips, *Cérérite* of Beudant, appears to be quite a distinct mineral.

* The composition of this mineral, according to Hisinger, is as follows:

Silica,	30.17
Alumina,	11.31
Protoxide of cerium,	28.19
Oxide of iron,	20.72
Lime,	9.12
Oxide of copper,	0.89
Volatile matter,	0.40

ORDER XI. SILVER.

1. Native Silver. 2. Vitreous Silver.

NATIVE SILVER.

Argent Natif. *Haüy* and *Beudant.* — Native Silver. *Cleaveland, Phillips, Thomson* and *Shepard.* — Hexahedral Silver. *Jameson.* — Hexaedrisches Silber. *Mohs.*

Description. Colour silver-white, but usually more or less tarnished externally. Streak shining. It occurs regularly crystallized; also massive, disseminated, capillary, branching and reticulated. The primary form is thought to be a cube, but it is also found in the form of a regular octahedron. Cleavage none. Fracture hackly. Lustre metallic. Opaque. Flexible, ductile and malleable. Hardness from 2.5 to 3.0. Specific gravity 10.74. Fusible by the blowpipe into a globule, which is not altered by continuing the heat, although on cooling it exhibits faces of the cube, the octahedron and dodecahedron. It is soluble in nitric acid, and the solution gives a white precipitate on the addition of common salt, which, on exposure to the light, assumes a purple colour.

Native silver is sometimes associated with gold, when it is known by the name of *Auriferous Native Silver.* A variety of this gave Klaproth, silver 34.00, gold 64.00; but these proportions are subject to great variation.

Geological Situation. Native silver generally occurs in veins of calcareous spar or quartz, traversing gneiss, slate, and other primitive rocks, occasionally also in selenite and clay. The most remarkable localities are the mines of Konsberg in Norway, which formerly afforded magnificent specimens; and those of Peru and Mexico in South America.

LOCALITIES.

Cleaveland enumerates several localities of native silver in the northern States. Among these is one at Sing-Sing in Westchester county, New-York, first noticed by Col. Gibbs; another in New-Jersey; and still another, at Huntington in Connecticut.

The occurrence of native silver in this State, although doubted, has been confirmed by Dr. Torrey, who informs us, that in 1825, Mr. F. Cozzens obtained a specimen from the mine about a mile south of the Sing-Sing prison.* This mine was wrought for silver, during the American revolution, but probably with little success. In 1827, a company was formed for the purpose of working it. The old shaft was cleared out, and an adit or level commenced. A small quantity of ore, principally galena, was obtained, and the work was then abandoned. Native silver has recently been found at King's mine in Davidson county, North Carolina†;

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* *Annals of the Lyceum of Natural History of New-York.* IV. 76. † Prof. J. C. Booth. *American Journal of Science.* XLI. 348.

and small filaments of the same metal have undoubtedly been obtained at the Bridgewater copper mines in New-Jersey.

VITREOUS SILVER.

Argent Sulfuré. *Haüy.* — Sulphuret of Silver. *Cleaveland, Phillips* and *Thomson.* — Vitreous Silver. *Shepard.* — Hexahedral Silver-Glance. *Jameson.* — Hexaedrischer Silber-Glanz. *Mohs.* — Argyrose. *Beudant.*

Description. Colour blackish lead-grey, with occasionally an iridescent tarnish. Streak shining. It occurs regularly crystallized, most frequently in cubo-octahedrons; also massive, disseminated, in plates or leaves, filiform, capillary, dentritic, reticulated, etc. The primary form is a cube. Traces of cleavage sometimes observable parallel to the faces of the rhombic dodecahedron. Fracture uneven, sometimes flat conchoidal. Lustre metallic. Opaque. Malleable. Flexible, but not elastic. Hardness from 2.0 to 2.5. Specific gravity from 6.90 to 7.20. Before the blowpipe, it intumesces, the sulphur is driven off, and a bead of pure silver remains. It is soluble in nitric acid, and may be precipitated in the form of metallic grains upon a clean plate of copper.

Composition. Silver 87.05, sulphur 12.96 (*Berzelius*). Formula AgS.

Geological Situation. It occurs chiefly in veins in gneiss, mica slate and greywacke, associated with ores of silver, lead and antimony, blende, pyrites and calcareous spar. It is abundantly met with in Mexico, and most of the silver obtained from the celebrated mines of Guanaxuato is extracted from this ore. A black decomposed variety known by the name of *Silver black*, often accompanies this mineral.

LOCALITIES.

This species is said to have been found at Livingston's lead mine in Columbia county. It is probable also that it exists in those varieties of galena which yield silver by the process of cupellation, as those of Sullivan county.

ADDITIONS.

TERENITE.

[From the Greek τερεν, *tender;* a characteristic property of the mineral.]

Terenite. *Emmons* (*New-York Geological Reports*, 1837).

Description. Colour yellowish white or pale yellowish green. It has a cleavage parallel to the sides of a square prism, and in the direction of its diagonal. Lustre faint pearly. Hardness 2.0. Specific gravity 2.53. Before the blowpipe, in the external flame, it is instantly changed into a white enamel; in the interior, it fuses readily with ebullition into a porous glass. With nitrate of cobalt, this enamel becomes of a lively blue colour.

Geological Situation. In white granular carbonate of lime, a primary rock.

Jefferson County. This mineral has heretofore been found only in Antwerp, associated with calcareous spar and foliated plumbago. All the information which I have in regard to it, is that derived from the notice published by Dr. Emmons as above quoted.

QUARTZ (Page 267).

Fine specimens of calcedony and chrysoprase, associated with calcareous spar, have been found at Belmont's lead mine, in St. Lawrence county (*Emmons*).

BITUMEN (Page 182).

Mr. Vanuxem states that he found petroleum in the septaria above the Tully limestone, near Ogden's ferry on Cayuga lake. It was accompanied, likewise, by a liquid substance of the colour of phosphate of iron or prussian blue, and by another substance like spermaceti before the oil is fully pressed out. It was composed of fine scales, had a yellowish white colour, was in small irregular masses, with the appearance of having been melted. Both of these two last substances are new.*

I regret that I can add nothing to the above notice of these singular products.

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* Vanuxem. *New-York Geological Reports*, 1839.

NATIVE IRON (Page 382).

Prof. Shepard refers to the occurrence of a mass of supposed native iron in the town of Scriba, near Oswego. The weight was about eight pounds. It was found to be composed of iron 99.68, silicon 0.20, calcium 0.09, aluminum traces. Specific gravity 7.50. Associated with the above iron, there is a brittle mineral resembling graphite, a part of which is magnetic, while the rest is not acted on by the magnet. It is thought to be ordinary magnetic iron ore.*

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* Shepard. *American Journal of Science*, XL. 366.

CATALOGUE

OF

AMERICAN MINERALS,

NOT HITHERTO FOUND IN THE STATE OF NEW-YORK; WITH SHORT DESCRIPTIONS, LOCALITIES, &c.

ALPHABETICALLY ARRANGED.

BISMUTHINE.

Sulphuret of Bismuth. *Cleaveland* and *Phillips.*

Colour lead or steel-grey. Crystallized and massive. Primary a right rhombic prism. M on M′ about 91°. Lustre metallic. Hardness 2.0 to 2.5. Sp. gr. 3.64. Before the blow-pipe, volatilized and easily fused. Composed of bismuth 60, sulphur 40.

Occurs at Haddam, Connecticut.

BISMUTH OCHRE.

Oxide of Bismuth. *Cleaveland.*

Colour yellowish. Massive, earthy and pulverulent. Soft. Sp. gr. 4.36. Reduced to the metallic state on charcoal. Composed of bismuth 89.87, oxygen 10.13.

It accompanies the preceding.

BLACK MANGANESE.

Hausmannite. *Haidinger.*

Colour brownish or iron black. Crystallized and massive. Primary an octahedron with a square base. P on P′ 117° 30′. Lustre imperfect metallic. Hardness 5.0 to 5.5. Sp. gr.

4.70 to 4.80. Before the blowpipe, fuses on the edges. Composed of oxide of manganese 75.80, silica 13.17, oxide of iron 4.14, alumina 2.80.

At Lebanon in Pennsylvania.

CALAMINE.

Carbonate of Zinc. *Cleaveland* and *Phillips.*

Colour greyish or yellowish. Crystallized, compact and earthy. Primary an obtuse rhombohedron of 107° 40′. Lustre between vitreous and pearly. Hardness 5.0. Sp. gr. 4.20 to 4.50. Infusible before the blowpipe. Composed of oxide of zinc 64.80, carbonic acid 35.20.

Brookfield, Connecticut; Franklin, New-Jersey; Perkiomen, Pennsylvania; and at the lead mines in Missouri.

CHLOROPHÆITE.

Chlorophæite. *MacCulloch* and *Cleaveland.*

Colour, when recently broken, from the transparent green of chrysolite, to the dull muddy green of steatite; when exposed for a few hours, it turns darker, and at length becomes black. Occurs in nodules, often round, and varying in size. Soft. Brittle. Sp. gr. 2.02. Before the blowpipe, it remains unchanged. Composed principally of silica and iron, with a little alumina.

This mineral, which occurs in Scotland and Iceland in amygdaloid, has also been found at Gill in Massachusetts, Southbury in Connecticut, and elsewhere in the United States. It is, however, still a doubtful species.

CHLOROPHYLLITE.*

Colour green. In tabular or short six-sided prisms arranged in folia or in columnar masses, resulting from the openness of natural joints. Cleaves into regular six-sided prisms with resplendent surfaces. Harder than apatite. Sp. gr. 2.70. Before the blowpipe, is glazed on the surface, but is not entirely fused. Composed of silica 45.20, phosphate of alumina 27.60, magnesia 9.60, protoxide of iron 8.26, manganese 4.10, water 3.60, traces of potash and loss 1.64.

Unity, New-Hampshire.

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* C. T. Jackson. *Report on the Geology of New-Hampshire*, 1841.

CHRYSOCOLLA.

Copper Green. *Cleaveland.*

Colour emerald and pistachio-green, passing into blue; brownish when impure. Massive, stalactitic, in crusts, etc. Semi-transparent to opaque. Hardness 2.0 to 3.0. Sp. gr. 2.00 to 2.20. Changes colour, but is infusible before the blowpipe. Composed of oxide of copper 45.17, silica 37.25, water 17.00.

At the Bridgewater copper mine near Somerville, N. Jersey; and at other deposits of copper ores in the same State. Also on Lake Superior.

COLUMBITE.

Ferruginous Oxide of Columbium. *Cleaveland.* — Tantalite. *Allan.*

Colour black. In crystals or crystalline masses. Primary a right rectangular prism. Lustre shining. Opaque. Hardness 6.0. Sp. gr. 6.00 to 6.30. Infusible before the blowpipe. Composed of columbic acid 67.60, oxide of tin 8.70, oxide of iron 7.60, oxide of manganese 5.90, tungstic acid 8.70, lime 1.50.

Haddam, Chesterfield and Beverly in Massachusetts; Middletown in Connecticut; and Acworth, New-Hampshire.

COPPER NICKEL.

Arsenical Nickel. *Cleaveland.*

Colour copper-red. Massive; very rarely crystallized. Lustre shining and metallic. Hardness 5.0 to 5.5. Sp. gr. 6.60 to 7.70. Melts before the blowpipe, and gives out an arsenical vapour. Composed of nickel 44.21, arsenic 54.73, with a little lead, iron and sulphur.

Chatham, Connecticut, with smaltine.

CORNEOUS LEAD.

Carbonated Muriate of Lead. *Cleaveland.*

Colour white, greyish or yellow. Crystallized. Primary a right rectangular prism. Lustre adamantine. Hardness less than 3.0. Sp. gr. 6.06. Melts before the blowpipe into a yellow globule, which becomes white on cooling. Composed of oxide of lead, with variable proportions of carbonic and muriatic acids.

Southampton, Massachusetts, accompanying galena.

CUMMINGTONITE.*

Colour greyish white. In fine needles and tufts of imperfect crystals. Lustre silky. Opaque. Hardness 6.5. Sp. gr. 3.20. Infusible before the blowpipe. Composed of silica 56.54, protoxide of iron 21.67, protoxide of manganese 7.80, soda 8.44, volatile matter 3.18.

Cummington and Plainfield in Massachusetts.

DANBURITE.†

Colour shades of honey-yellow. Crystallized. Primary an oblique rhombic prism. Lustre highly vitreous. Transparent. Hardness 7.5. Sp. gr. 2.83. Phosphoresces before the blowpipe, and fuses into a white blebby transparent glass. Composed of silica 56.00, lime 28.33, alumina 1.70, yttria? 0.85, potassa (with soda?) and loss 5.12, water 8.00.

Danbury, Connecticut.

DYSLUITE.‡

Colour yellowish or greyish brown. Crystallized. Primary the regular octahedron. Lustre vitreous, inclining to resinous. Nearly or quite opaque. Hardness 7.05. Sp. gr. 4.55. Before the blowpipe, it assumes a red colour, but does not melt. Composed of alumina 30.49, oxide of zinc 16.80, peroxide of iron 41.93, protoxide of manganese 7.60, silica 2.97.

Sterling, New-Jersey, with franklinite and troostite. It has been thought to be identical with automalite.

ELECTRIC CALAMINE.

Siliceous Oxide of Zinc. *Cleaveland.*

Colour usually white or yellow. Crystallized and massive. Primary a right rhombic prism. M on M′ 108° 40′. Lustre vitreous. Transparent to opaque. Hardness 5.0. Sp. gr. 3.30 to 3.60. Infusible before the blowpipe. Composed of oxide of zinc 66.83, silica 24.89, water 7.46.

Jefferson county, Missouri, with galena and other lead ores.

EREMITE.§

Colour between clove and yellowish brown. Crystallized. Primary a right oblique angled prism. M on T 140° 30′. Lustre resinous to vitreous. Semi-transparent. Hardness 5.0 to 5.5. Sp. gr. 3.71. Infusible by the blowpipe, but becomes transparent and colourless.

Watertown, Connecticut, in a bowlder of albitic granite.

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* Thomson. *Outlines of Mineralogy, &c.*

† Shepard. *American Journal of Science.* XXXV. 137.

‡ Thomson. *Outlines of Mineralogy, &c.*

§ Shepard. *American Journal of Science.* XXXII. 341.

EUCLASE.

Colour white, blue and green. Crystallized. Primary a right oblique angled prism. M on T 130° 52′. Lustre vitreous and splendent. Transparent and translucent. Hardness 7.5. Sp. gr. 2.90 to 3.20. Very easily frangible. Before the blowpipe, it becomes opaque, and then melts on the edges into a white enamel. Composed of silica 43.22, alumina 30.56, glucina 21.78, oxide of iron 2.22, oxide of tin 0.70.

Lane's mine, Connecticut, where it has recently been found.*

FRANKLINITE.

Colour iron-black. In imperfect crystals or grains. Primary form a regular octahedron. Lustre metallic. Acts slightly on the magnet. Hardness 6.0 to 6.5. Sp. gr. 5.00. Infusible before the blowpipe. Composed of peroxide of iron 66.00, oxide of zinc 17.00, red oxide of manganese 16.00.

Franklin furnace in Hamburg, New-Jersey.

HARMATOME.

Colour white, passing into grey, yellow, red and brown. Crystallized. Primary a right rectangular prism. Lustre vitreous. Transparent to translucent. Hardness 4.0 to 4.5. Sp. gr. 2.40 to 2.45. Fuses before the blowpipe into a clear globule. Composed of silica 49.00, alumina 16.00, baryta 18.00, water 15.00.

Bound brook, New-Jersey, in trap?

IOLITE.

Colour blue inclining to black. Crystallized and massive. Primary a regular six-sided prism. Lustre vitreous. Transparent or translucent. Infusible before the blowpipe, except on very thin edges. Composed of silica 48.54, alumina 31.73, magnesia 11.30, oxide of iron 5.69, oxide of manganese 0.70, water, etc. 1.65.

Haddam, Connecticut, in gneiss; Brimfield, Mass.

LEUCOPYRITE.

Leucopyrite. *Shepard* and *Dana*. — Axotomous Arsenical Pyrites. *Jameson*.

Colour white, to steel-grey. Crystallized and massive. Primary a right rhombic prism. M on M 122° 26′. Lustre metallic. Hardness 5.0 to 5.5. Sp. gr. 7.22 to 7.34. Melts

* Shepard. *American Journal of Science*. XLIII. 366.

before the blowpipe, but does not give out the odour of arsenic. Composed of iron 97.44, arsenic 1.56.

Bedford county, Pennsylvania; Randolph county, North-Carolina (*Shepard*).

MASONITE.*

Colour brown or blackish? In tabular crystals, the primary of which seems to be a right rhombic prism. Scratches glass. Specific gravity 3.45. Fusible with difficulty into a dark green enamel. Composed of silica 33.20, alumina 29.00, protoxide of iron 25.93, oxide of manganese 6.00, magnesia 0.24, water 4.00.

Near Wickford, Rhode-Island, in bowlders; also in Ward, Worcester county, Mass.

MICROLITE.†

Colour straw yellow to reddish brown. Crystallized. Primary a regular octahedron. Lustre resinous. Hardness 5.0 to 5.5. Specific gravity 4.75 to 5.00. Infusible before the blowpipe.

Chesterfield, Massachusetts, in a vein of albite, with tourmaline. The crystals are very minute.

MONAZITE.‡

Colour hyacinth red to reddish brown. Crystallized. Primary an oblique rhombic prism. M on M′ 95° 30′. Lustre vitreous to adamantine. Transparent to translucent. Hardness 5.0. Sp. gr. 4.99 to 5.08. Infusible before the blowpipe. Composed of peroxide of cerium, thorina, peroxide of tin, phosphoric acid, etc.

Norwich, Connecticut, with bucholzite.

NATIVE GOLD.

Colour bright yellow. Crystallized, capillary, ramified, in grains, and in masses. Soft, flexible and malleable. Lustre metallic. Hardness 2.5 to 3.0. Sp. gr. 17.00 to 19.00. It usually contains small proportions of silver and iron. Melts easily.

In various parts of the United States, from Canada to Georgia; seldom, however, in quantities large enough for profitable exploration.

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* C. T. Jackson. *Geological Survey of Rhode-Island*, 1840. † Shepard. *American Journal of Science*. XXVII. 361.
‡ Dana. *System of Mineralogy*.

NITRE.

Nitrate of Potash. *Cleaveland.*

Colour white. In capillary crystals and crusts. Transparent to semi-transparent. Hardness 2.0. Sp. gr. 1.94. Dissolves in water. Composed of nitrate of potash, and several salts of lime, in variable proportions.

With nitrate of lime and other salts, in the salt-petre caves of Kentucky, &c.

PETALITE.

Colour white or reddish white. In lamellar masses. Lustre glistening. Translucent. Hardness 6.0. Sp. gr. 2.44. Before the blowpipe, it melts only on the edges. Composed of silica 79.21, alumina 17.22, lithia 5.76.

Bolton, Massachusetts.

PINITE.

Colour grey, greyish green or brown. Crystallized. Primary a hexagonal prism. Lustre sometimes resinous. Opaque. Hardness 2.0 to 2.50. Sp. gr. 2.75 to 2.78. Whitens before the blowpipe, and fuses on thin edges, but does not melt. Composed of silica 55.96, alumina 25.48, potash 7.89, soda 0.39, peroxide of iron 5.51, magnesia with manganese 3.76, water 1.41.

Lancaster in Massachusetts, and Haddam in Connecticut. It has been thought to be a variety of mica.

POLYMIGNITE.

Colour black. In prismatic crystals. Primary a rhomboidal octahedron, the dihedral angles of which are 136° 28′, 116° 22′ and 80° 16′. Lustre imperfect metallic, but brilliant. Hardness 6.5. Sp. gr. 4.77 to 4.85. Infusible before the blowpipe. Composed of oxide of titanium, zirconia, yttria, oxide of iron, etc.

Beverly, Massachusetts (*Shepard*).

PURPLE COPPER.

Variegated Pyritous Copper. *Cleaveland.*

Colour between copper-red and tombac-brown. Streak pale greyish black and shining. Crystallized and massive. Primary a regular octahedron. Lustre metallic. Rather sectile. Hardness 3.0. Sp. gr. 5.00. Melts before the blowpipe. Composed of copper 61.07, sulphur 23.75, iron 14.00, silica 0.50.

Chesterfield, Massachusetts; Perkiomen, Pennsylvania.

RAPHILITE.*

Colour white, with a shade of bluish green. In diverging acicular crystals; the needles or fibres easily separable. Lustre between glassy and silky. Hardness 3.5 to 4.0. Sp. gr. 2.85. Before the blowpipe, becomes opaque and white, but does not melt into a globule. Composed of silica 56.48, lime 14.75, alumina 6.16, protoxide of iron 5.39, protoxide of manganese 0.45, magnesia 5.45, potash 10.53, moisture 0.50.

Perth, Upper Canada; Easton, Pennsylvania? It is perhaps only a variety of hornblende.

RED ZINC ORE.

Red Oxide of Zinc. *Cleaveland.*

Colour yellowish red. Massive. Lustre adamantine. Translucent on the edges. Hardness 4.0 to 4.5. Sp. gr. 5.43 to 5.52. Infusible before the blowpipe. Composed of oxide of zinc 88.00, oxide of iron and manganese 12.00.

Franklin and Sterling in New-Jersey.

Retinalite of Thomson, is a variety of Serpentine.

SAUSSURITE.

Colour white or grey. Massive. Lustre pearly, inclining to vitreous. Brittle. Hardness 5.5. Sp. gr. 3.25 to 3.34. Melts before the blowpipe, with difficulty, into a white glass. Composed of silica 49.00, alumina 24.00, lime 10.00, magnesia 3.75, oxide of iron 6.50, soda 5.50.

Canaan, Connecticut, in great abundance.

SILLIMANITE.†

Colour hair-brown to greyish brown. In long, slender, and often curved or bent crystals. Primary a rhombic prism. Lustre vitreous, inclining to pearly. Translucent. Hardness 7.0 to 7.5. Sp. gr. 3.20 to 3.24. Infusible before the blowpipe. Composed of silica 38.67, alumina 35.11, zirconia 18.51, oxide of iron 7.22.

Chester, Connecticut, in slender prisms in quartz. It may be a variety of bucholzite.

SMALTINE.

Grey Cobalt. *Cleaveland?*

Colour tin-white to steel-grey. Crystallized and massive. Primary a regular octahedron. Lustre metallic. Brittle. Hardness 5.5. Specific gravity 6.47. Melts before the blow-

* Thomson. *Outlines of Mineralogy, &c.*

† Bowen. *American Journal of Science*, VIII. 113.

pipe, with the evolution of arsenical vapours. Composed of arsenic 68.50, cobalt 9.60, iron 9.70, copper 1.00, sulphur 7.00.

Chatham, Connecticut, associated with arsenical iron pyrites and copper nickel.

TEPHROITE.

Tephroite. *Leonhard.*

Colour ash-grey, liver-brown to black. Massive and compact. Lustre adamantine. Hardness 5.0 to 6.0. Sp. gr. 4.10 to 4.12. Before the blowpipe, fuses into a black slag.

Sparta, New-Jersey, with franklinite. It is supposed by Shepard to be a variety of troostite.

TIN ORE.

Oxide of Tin. *Cleaveland.*

Colour white, grey, yellow, red, brown and black. Streak grey or brown. Crystallized and massive. Primary an octahedron with a square base. Lustre adamantine. Semi-transparent to transparent. Hardness 6.0 to 7.0. Sp. gr. 6.51 to 7.10. On charcoal, before the blowpipe, it is reduced to the metallic state. Composed of oxide of tin 95.00, oxide of iron 5.00.

Goshen, Massachusetts; and in considerable quantity in Jackson, New-Hampshire.

TOPAZ.

Colour various shades of yellow, green, blue or red. Streak white. Crystallized and massive. Primary a right rhombic prism. M on M′ 124° 22′. Lustre vitreous. Translucent to transparent. Hardness 8.0. Sp. gr. 3.49 to 3.56. Scarcely fusible before the blowpipe. Composed of alumina 57.45, silica 34.24, fluoric acid 7.75.

Middletown and Trumbull, Connecticut. A specimen from the vicinity of Carmel in Putnam county, N. Y., closely resembles topaz; but the crystals are too small and imperfect to determine positively.

TRIPLITE.

Phosphate of Manganese. *Cleaveland.*

Colour blackish brown. Massive. Lustre resinous, inclining to adamantine. Translucent on the edges to opaque. Brittle. Hardness 5.0 to 5.5. Sp. gr. 3.43 to 3.78. Melts before the blowpipe into a black scoria. Composed of oxide of iron 31.00, oxide of manganese 42.00, phosphoric acid 27.00.

Washington, Connecticut; Sterling, Massachusetts.

TROOSTITE.

Ferruginous Silicate of Manganese. *Thomson.*

Colour pale asparagus-green, yellow, grey and reddish brown. Crystallized and massive. Primary a rhombohedron. P on P 115°. Lustre vitreous. Transparent to translucent. Hardness 5.5. Sp. gr. 4.00 to 4.10. Before the blowpipe, it melts on the edges. Composed of silica 30.65, protoxide of manganese 46.21, peroxide of iron 15.45, moisture and carbonic acid 7.30.

Sterling, New-Jersey, with franklinite.

TUNGSTEN.

Tungstate of lime. *Dana* and *Phillips.*

Colour white, grey, yellowish and reddish brown. Streak white. Crystallized and massive. Primary an octahedron with a square base. Lustre vitreous, inclining to adamantine. Semi-transparent to translucent. Hardness 4.0 to 4.5. Sp. gr. 6.08. Fuses with difficulty before the blowpipe. Composed of lime 19.40, tungstic acid 80.42.

Monroe and Trumbull, Connecticut.

TUNGSTIC OCHRE.

Yellow oxide of Tungsten. *Cleaveland.*

Colour orange or chrome-yellow to yellowish grey. Massive ; earthy and pulverulent. Soft. Sp. gr. 6.0. Assumes a green hue when strongly heated. Composed of oxygen 13.55, tungsten 86.45 ?

Lane's mine in Monroe, Connecticut, with tungsten and wolfram.

URANITE.

Green Oxide of Uranium. *Cleaveland.*

Colour yellow and green. Crystallized and massive. Primary a right square prism. Lustre pearly upon the face P. Transparent to opaque. Hardness 2.0 to 2.5. Sp. gr. 3.12. Composed of phosphoric acid, lime, oxide of uranium and water, with traces of fluoric acid and ammonia, etc.

Middletown, Connecticut, with columbite, etc. ; Chesterfield, Massachusetts, with albite.

WOLFRAM.

Ferruginous Oxide of Tungsten. *Cleaveland.*

Colour dark greyish, or brownish black. Crystallized and massive. Lustre brilliant, often metallic. Opaque. Brittle. Hardness 5.0 to 5.5. Sp. gr. 7.11 to 7.40. Composed of tungstic acid 67.00, oxide of iron 18.00, oxide of manganese 6.25, silica 1.50.

Lane's mine, and Trumbull, Connecticut.

TABLES

OF

CRYSTALLINE FORMS.

TABLES

OF THE

CRYSTALLINE FORMS INTRODUCED INTO THE DESCRIPTIVE PART OF THIS WORK,

WITH THE MEASUREMENTS OF THEIR SEVERAL ANGLES.

[The figures in the tables correspond to those in the body of the work.]

SULPHUR. Figs. 14 and 15. Page 181.

Fig. 14. The primary, an octahedron with a rhombic base.

P on P .. 106°38′ and 84° 58′
P on P′ .. 144 17 (*Beudant*);
143 7 48 (*Haüy*).
P on *r* .. 108 26 6 (*Haüy*).

GRAPHITE. Fig. 16. Page 186.

Six-sided tables cleaveable into rhombs in the direction of the dotted lines.

GLAUBER'S SALT. Figs. 17 and 18. Page 196.

Fig. 17. The primary, an oblique rhombic prism.

M on M′..... 99° 36′;
or, according to Haüy, an octahedron with a rhombic base, Fig. 18.

NATRON. Figs. 19 and 20. Page 197.

Fig. 20. The primary, according to Haüy.

P on P ..... 143° 8′
P on P′..... 113 54

NATRON.

Fig. 19. A secondary form from solution.

P on *o* ..... 140°46′

COMMON SALT. Figs. 21 and 23. Page 198.

Fig. 21. The primary, a cube.

Fig. 22. A hollow quadrangular pyramid formed by the slow evaporation of a solution of common salt.

SULPHATE OF POTASH. Figs. 23 to 25 inclusive. Page 201.

Fig. 23. The primary, a right rhombic prism.

M on M′ .. 118° 8′ (*Beudant.*)

Figs. 24 and 25, other forms of sulphate of potash.

ALUM. Figs. 26 to 28 inclusive. Page 202.

Fig. 26. The primary a regular octahedron.

Figs. 27 and 28, modifications of the primary.

Fig. 14.

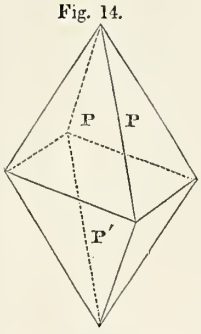


Fig. 15.

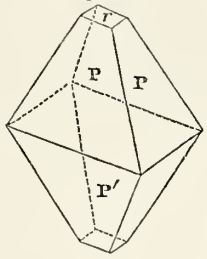


Fig. 16.

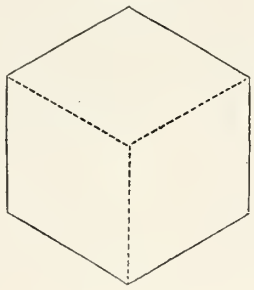


Fig. 17.

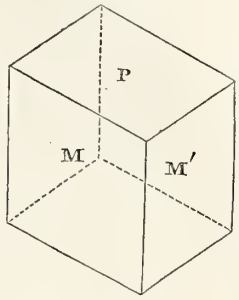


Fig. 18.

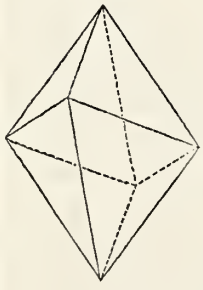


Fig. 19.

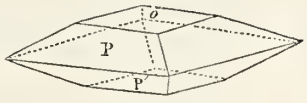


Fig. 20.

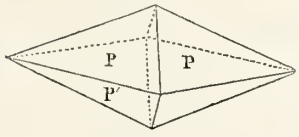


Fig. 21.

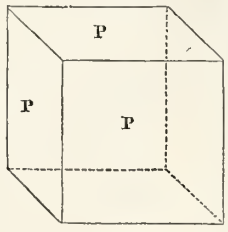


Fig. 22.

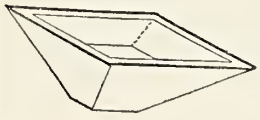


Fig. 23.

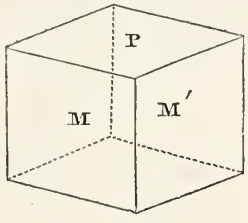


Fig. 24.

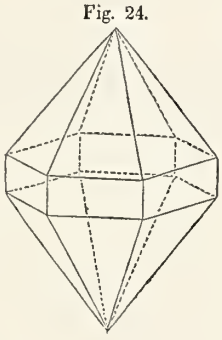


Fig. 25.

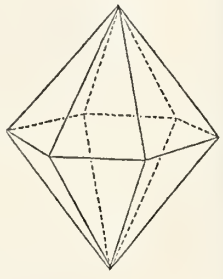
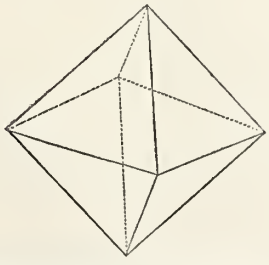


Fig. 26.



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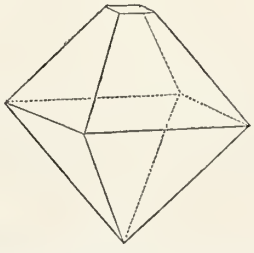

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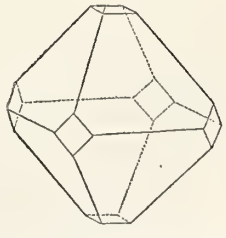


HEAVY SPAR. Figs. 29 to 46 inclusive. Page 204.

Fig. 29. The primary, a right rhombic prism.

M on M′	101°	42′	0″
M or M′ on P	90	0	0
M on *k*	129	13	54
M on *z*	154	26	52
P on *d*	140	59	21
P on *k*	90°	0′	0″
P on *l*	157	56	59
P on *o*	127	5	13 *
d on *d*	78	1	58
d on *l*	163	2	22
k on *o*	142	8	47
o on *o*	105	49	34
o on *z*	135	39	58
z on *z*	110	25	58

* This is incorrectly printed in the body of the work (page 205) 137° 5′ 13″.

Fig. 29.

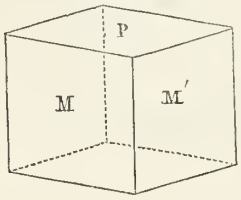


Fig. 30.

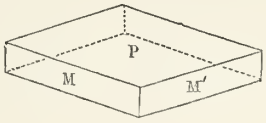


Fig. 31.

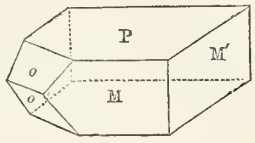


Fig. 32.

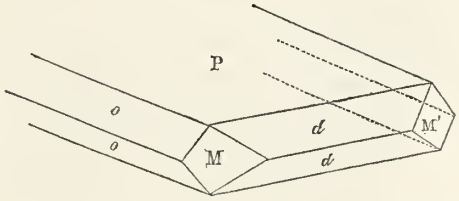


Fig. 33.

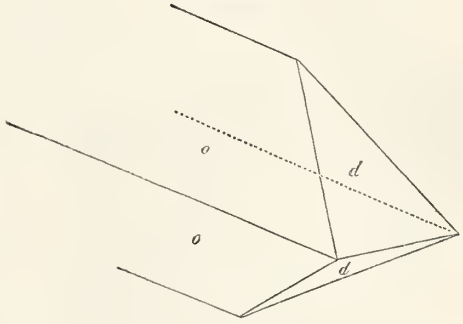


Fig. 34.

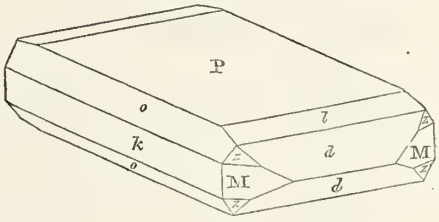


Fig. 35.

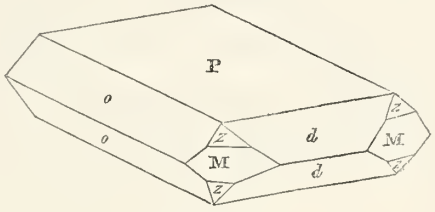


Fig. 36.

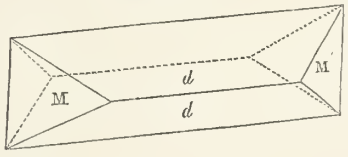


Fig. 37.

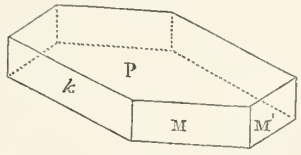


Fig. 38.

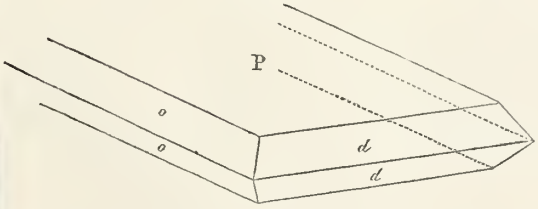
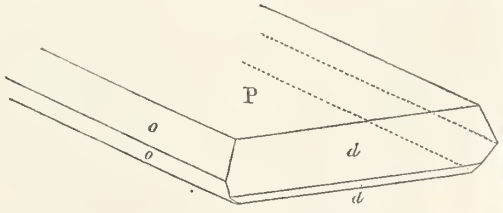


Fig. 39.



HEAVY SPAR. (Continued.)

M on *t*	169°19′ 45″
P on *r*	162 2 44
d on *s*	129 0 39
d on *u*	160 41 39
r on *r*	35 54 32
s on *t*	151 26 21
u on *u*	116 38 0

CELESTINE. Figs. 47 to 50 inclusive. Page 210.

Fig. 47. The primary, a right rhombic prism.

M on M′	104° to 104°48′
M or M′ on P	90 0

CELESTINE.

P on *l*	157°47′
P on *o*	128 31
P on *s*	90 0
d on *d*	78 28
d on *l*	162 69

STRONTIANITE. Figs. 51 to 54 inclusive. Page 212.

Fig. 51. The primary, a right rhombic prism.

M on M′	117°32′
M or M′ on P	90 0

Fig. 40.

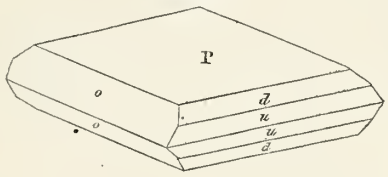
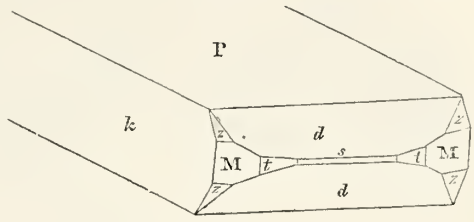


Fig. 41.



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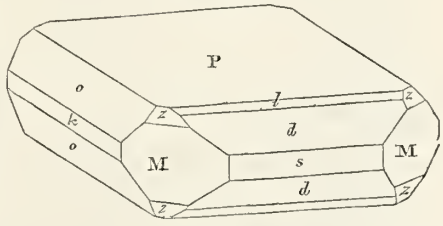

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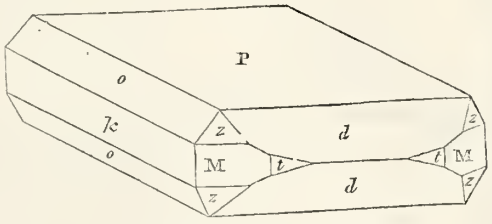

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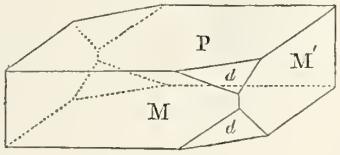


Fig. 45.

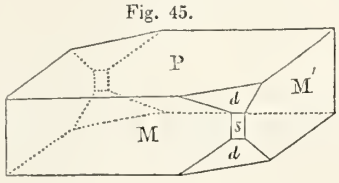


Fig. 46.

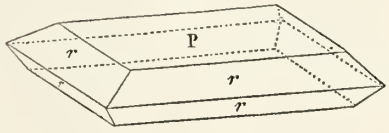


Fig. 47.

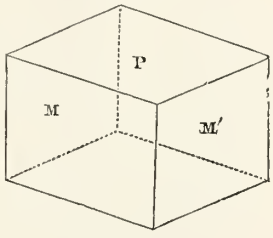


Fig. 48.

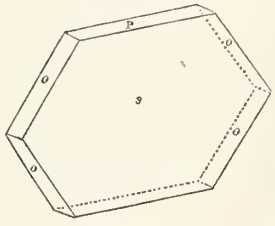
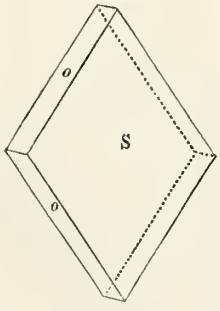


Fig. 49.



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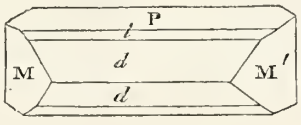
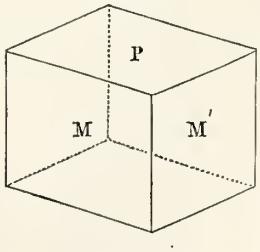


Fig. 51.



STRONTIANITE. (Continued.)

P on *a*	120°	0′
o on *o*	160	0
a on *a*	120	0

CALCAREOUS SPAR. Figs. 55 to 100 inclusive. Page 215.

Fig. 55. The primary, a rhombohedron.

Figs. 56 and 57, secondary forms showing the reduction by cleavage to the primary.

CALCAREOUS SPAR.

P on P	105°5′ and	74°55′	0″
P on *r*	151	3	0
c on *c*	120	0	0
c on *g*	116	33	55
g on *g*	134	26	0
r on *r*	144	20	26
r on *r′*	104	28	40
r on *r″*	133	26	0

Fig. 52.

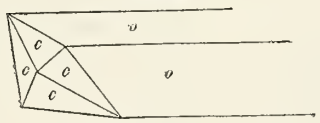


Fig. 53.

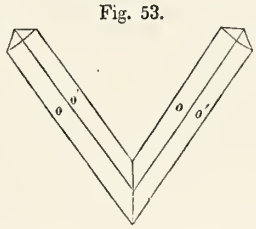


Fig. 54.

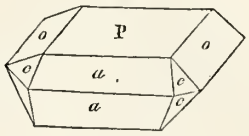


Fig. 55.

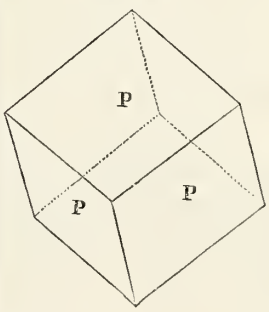


Fig. 56.

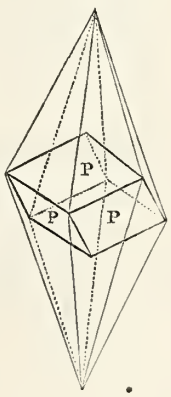


Fig. 57.

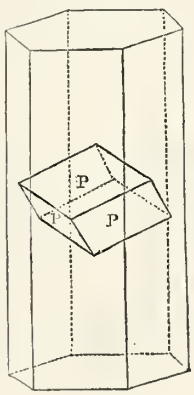


Fig. 58.

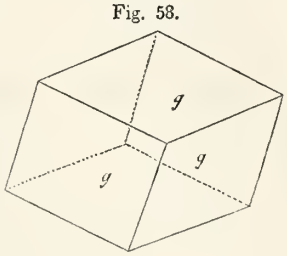


Fig. 60.

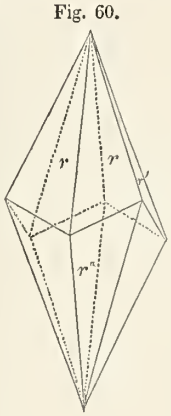


Fig. 61.

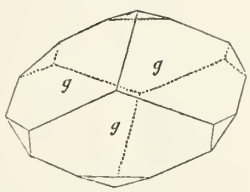


Fig. 62.

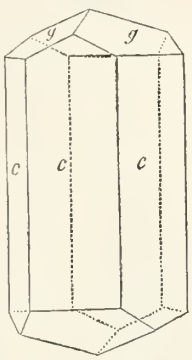


Fig. 63.

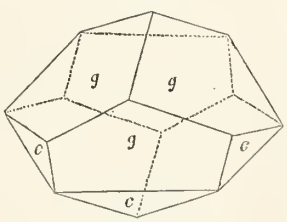


Fig. 64.

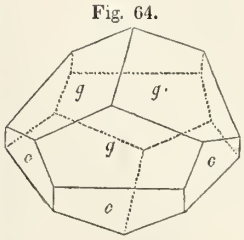


Fig. 65.

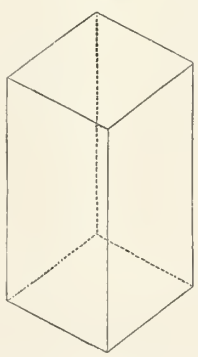


Fig. 66.

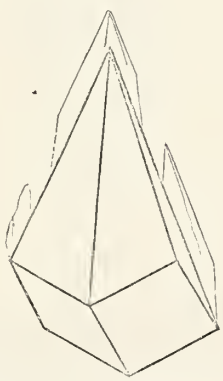
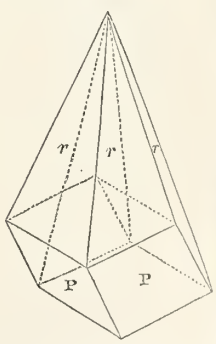


Fig. 67.



CALCAREOUS SPAR. (Continued.)

c on g	116°33′55″
c on o	90 0
h on h'	92 12
m on m'	114 19

Fig. 76 is a twin crystal from Martinsburgh, Lewis county, and Haverstraw, Rockland.

CALCAREOUS SPAR.

Fig. 79 is a twin from Patterson, Putnam county. Face of composition perpendicular to the axis of the aggregated crystals: angle of revolution 60°.

Fig. 68.

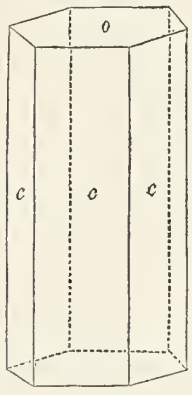


Fig. 69.

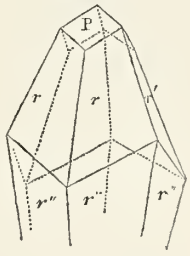


Fig. 70

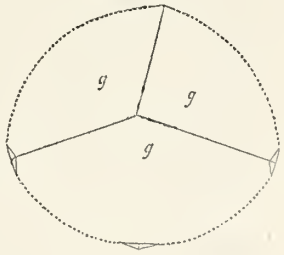


Fig. 71.

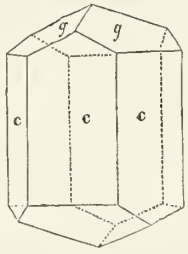


Fig. 72.

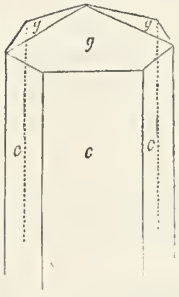


Fig. 73.

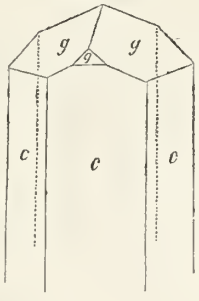


Fig. 74.

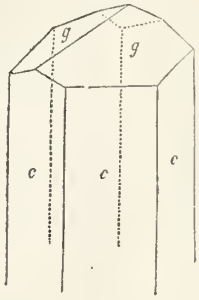


Fig. 75.

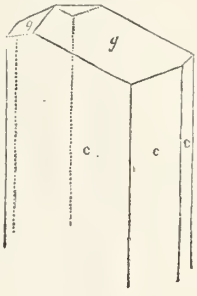


Fig. 76.

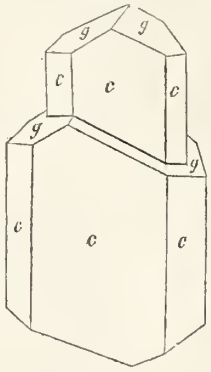


Fig. 77.

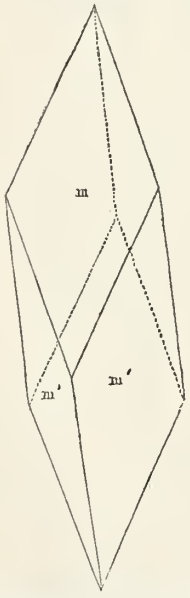


Fig. 78.

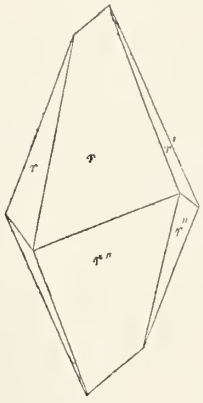


Fig. 79.

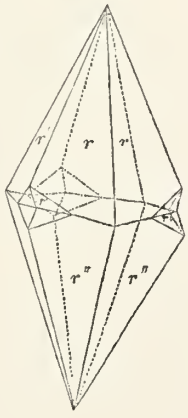
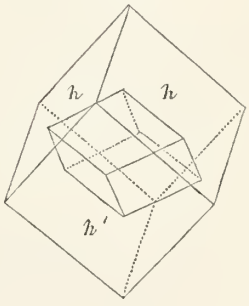


Fig. 80.



CALCAREOUS SPAR. (Continued.)

P on *c*	135°	0′	0″
P on *m*	149	2	11
P on *r* or *r*′	151	2	40
P on *s*	119	2	11
c on *r* or *c*′ on *r*	152	6	50
g on *i*	112	10	0
g on *s*	127	52	30
m on *s* or *m*′ on *s*′	121	32	54
m on *s*′ or *m*′ on *s*	154	39	13
s on *s*	63	44	55
s on *s*′	116	15	5
t on *t*	137	39	26

Fig. 83. A twin from Haverstraw, Rockland county. Angle of revolution 60°.

CALCAREOUS SPAR.

Fig. 89. A twin similar to that represented in Fig. 79, but with the additional planes *t*.

Fig. 90. A twin from Haverstraw, Rockland county. Face of composition parallel with a plane passing through the vertical axis: angle of revolution 180°.

Fig. 91. Two solid angles of the primary rhombohedron replaced by tangent planes.

Figs. 92 and 93. Twins of the preceding.

Fig. 94. A twin from Rossie, St. Lawrence county.

Fig. 81.

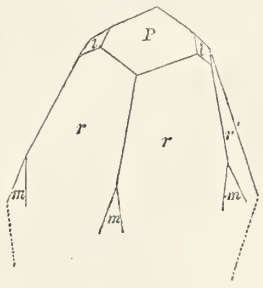


Fig. 82.

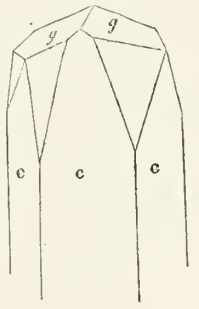


Fig. 83.

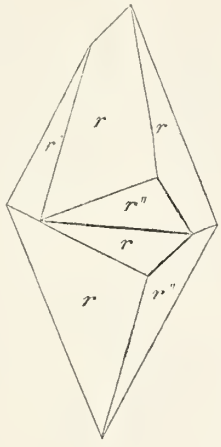


Fig. 84.

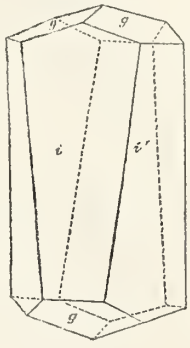
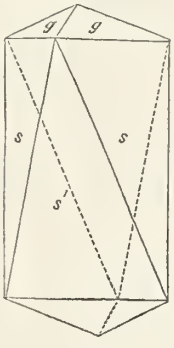


Fig. 85.



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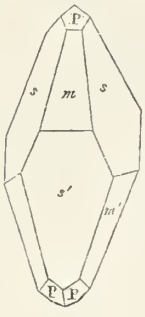

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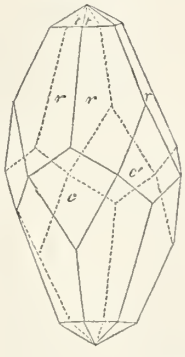

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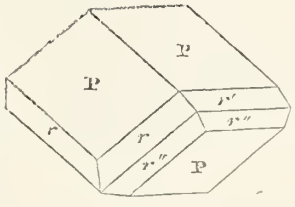
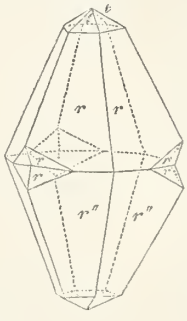


Fig. 89.



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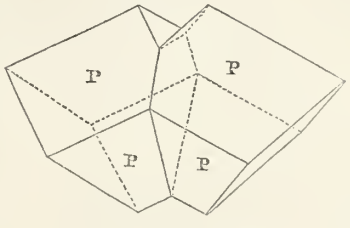

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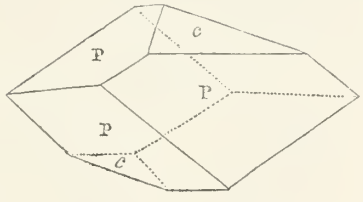

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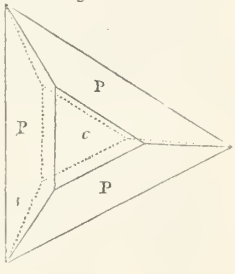

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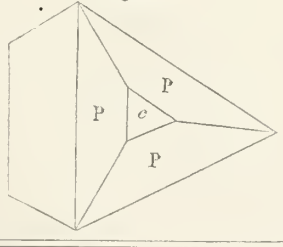
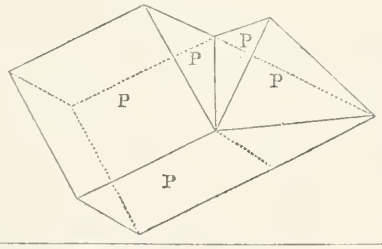


Fig. 94.



CALCAREOUS SPAR. (Continued.)

P on *g* ..... 143° 0′

(The other measurements will be found on the preceding pages.)

Figs. 97 and 98. Compound crystals from Rossie, St. Lawrence county.

Fig. 99. A crystal with a smaller one implanted. Rossie, St. Lawrence.

Fig. 100. A very acute rhombohedron.

ARRAGONITE. Fig. 101. Page 235.

The primary, a right rhombic prism.

M on M′ ..... 116° 5′

M or M′ on P 90 0

GYPSUM. Figs. 102 to 104 inclusive. Page 237.

Fig. 102. The primary, a right oblique angled prism.

M on T ..... 113° 8′

P on M or T 90 0

GYPSUM.

Fig. 103.

P on *f* ..... 124°41′43″

P on *l* 108 3 19

f on *f* 110 36 34

l on *l* 143 53 22

ANHYDRITE. Fig. 105. Page 238.

The primary, a right rectangular prism.

M on T ..... 90° 0′

P on M or T 90 0

APATITE. Figs. 106 to 113 inclusive. Page 239.

Fig. 106. The primary, a regular six-sided prism.

M on M ..... 120° 0′ 0″

M on *s* 135 0 0

M on *x* 129 13 53

x on *x* 143 7 48

Fig. 95.

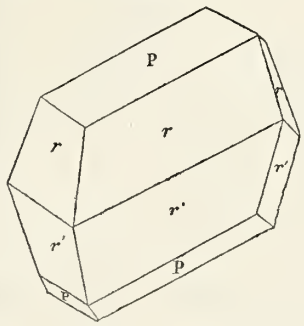


Fig. 96.

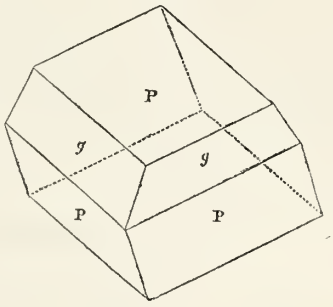


Fig. 97.

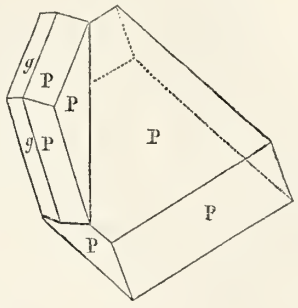


Fig. 98.

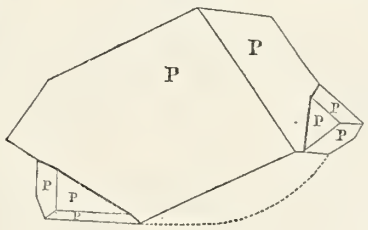


Fig. 99.

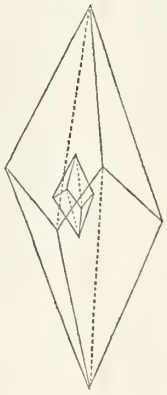
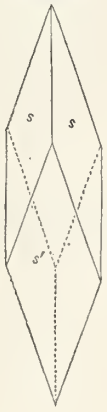


Fig. 100.



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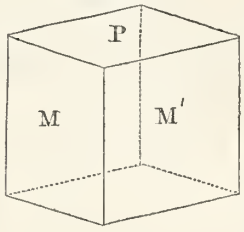

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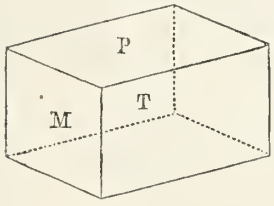
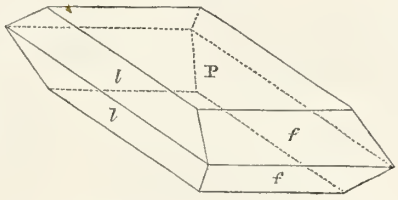


Fig. 103.



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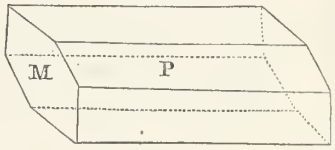

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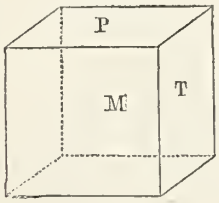

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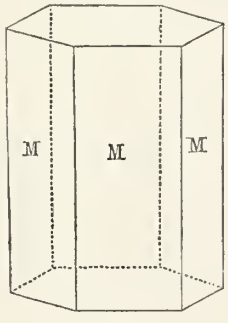

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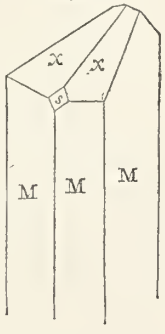

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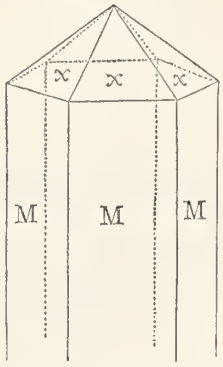


APATITE. (Continued.)

Fig. 109.

M on e ..... 150°

Figs. 110 and 111, represent the rounded terminations and bent prisms found at Hammond, St. Lawrence county.

Fig. 112. A compound crystal from the preceding locality.

Fig. 113.

M on x ..... 129°13′ 53″

P on x 140 46 7

FLUOR SPAR. Figs. 114 to 118 inclusive. Page 243.

Fig. 115. The primary, a regular octahedron.

P on P′ ..... 109°28′ 16″

Fig. 114, shows the manner in which the cubes of flour spar cleave into octahedrons and tetrahedrons.

FLUOR SPAR.

Fig. 117. The octahedron with the solid angles replaced.

P on i ..... 125°15′ 52″

DATHOLITE. Figs. 119 and 120. Page 246.

Fig. 119. The primary, a right rhombic prism.

M on M′ ..... 103°40′

PHARMACOLITE. Figs. 121 and 122. Page 247.

Fig. 121. The primary, a right oblique angled prism.

Fig. 122.

f on f ..... 117°24′

P * to the edge between

f and f ..... 83°14′

n on n 141 8

* Incorrectly o at page 257.

Fig. 109.

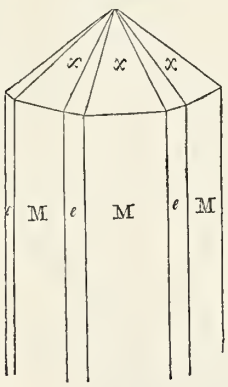


Fig. 110.

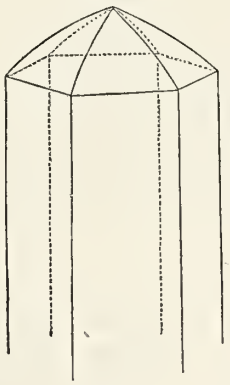


Fig. 111.

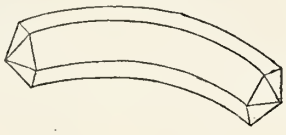


Fig. 112.

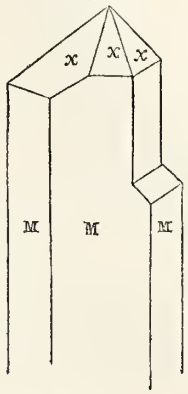


Fig. 113.

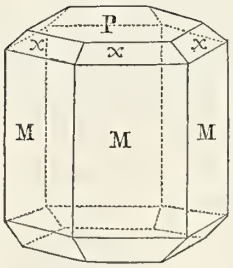
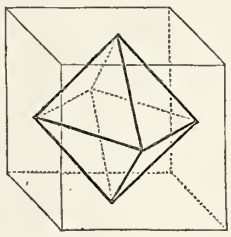


Fig. 114.



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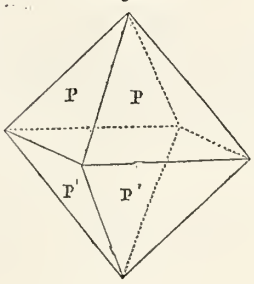


Fig. 116.

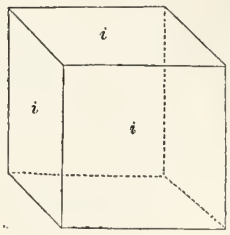


Fig. 117.

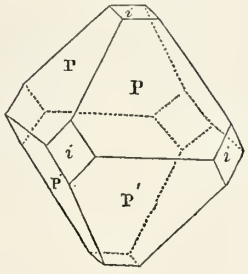


Fig. 118.

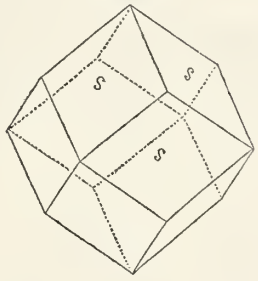
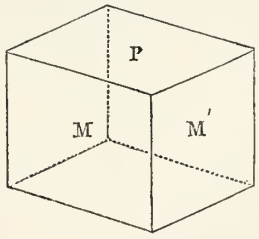


Fig. 119.



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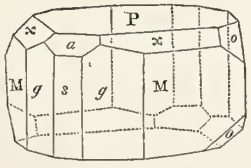


Fig. 121.

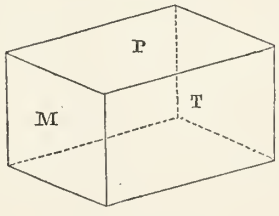
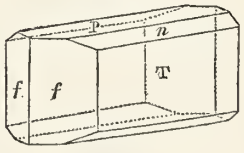


Fig. 122.



CARBONATE OF MAGNESIA. Page 249.

Fig. 123. The primary, a rhombohedron.

P on P ..... 107°25′ (*Beudant.*)

EPSOM SALT. Figs. 124 and 125. Page 251.

Fig. 124. The primary, a right rhombic prism nearly rectangular.

M on M′ ..... 90°30′

Fig. 125.

M or M′ on *l* 129 14

l on *l* 126 52

MAGNESIAN CARBONATE OF LIME. Figs. 126 to 128 inclusive. Page 252.

Fig. 126. The primary, a rhombohedron.

P on P ..... 106°15′

MAGNESIAN CARBONATE OF LIME.

Fig. 127. Bent crystals found in Herkimer and Niagara counties.

Fig. 128. A twin formed as in Fig. 90.

QUARTZ. Figs. 129 to 183 inclusive. Page 257.

Fig. 129. The primary, a rhombohedron.

P′ on P′ from 94°15′ to 94°24′

Fig. 130. A common secondary form, a six-sided prism, terminated by six-sided pyramids.

P on *r*, P′ on *r*′, *r* on *z*′ or *r*′ on *z* 140°40′

r on *r*′ ..... 120° 0′

Fig. 131, et seq.

P on *s* or *z* on *s* ..... 151° 7′

P on *z* or P′ on *z*′ 133 48

r on *s* or *r*′ on *s* 142 0

Fig. 123.

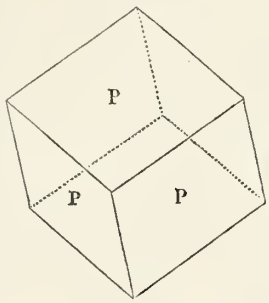


Fig. 124.

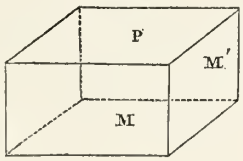
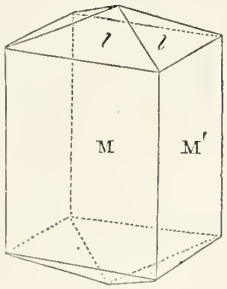


Fig. 125.



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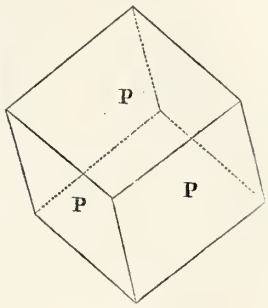


Fig. 127.

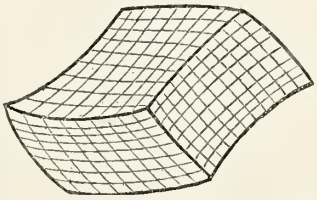


Fig. 128.

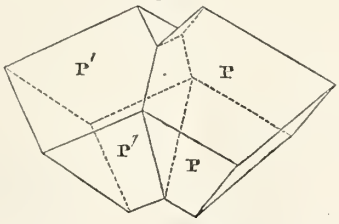
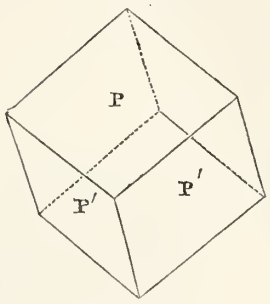


Fig. 129.



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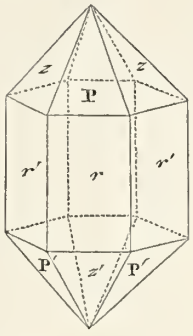

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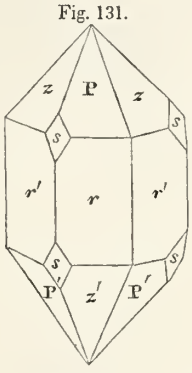


Fig. 132.

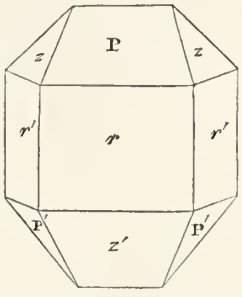


Fig. 133.

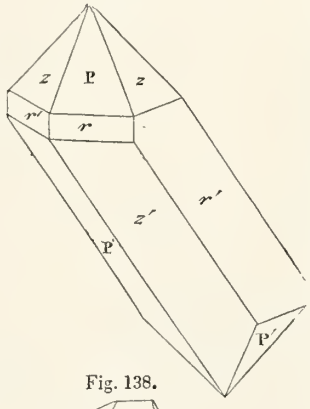


Fig. 134.

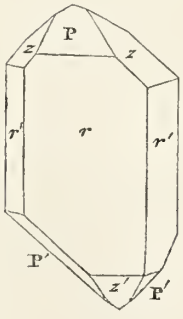


Fig. 135.

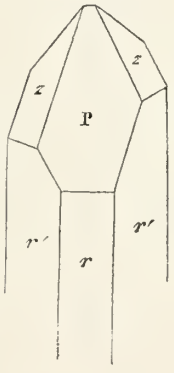


Fig. 236.

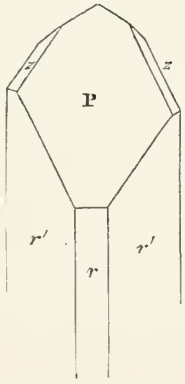


Fig. 137.

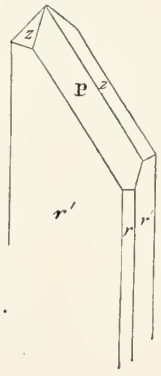
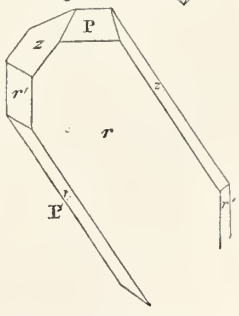


Fig. 138.



QUARTZ. (Continued.)

Figs. 139 and 140. Twin crystals from Catskill, Greene county. The latter also occurs in Herkimer county.

Fig. 148. A twin from Middleville, Herkimer county.

(The measurements will be found on page 476.)

Fig. 139.

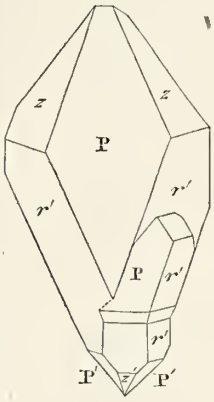


Fig. 140.

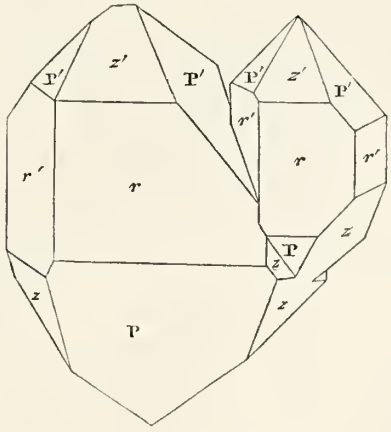


Fig. 141.

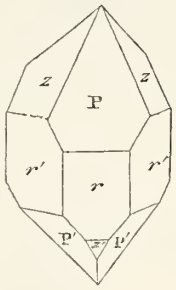


Fig. 142.

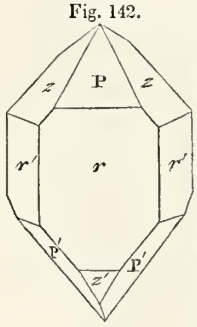


Fig. 143.

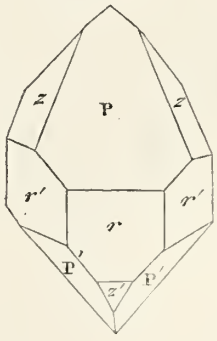


Fig. 144.

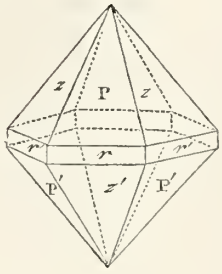


Fig. 145.

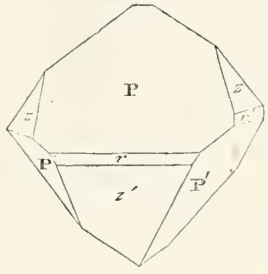


Fig. 146.

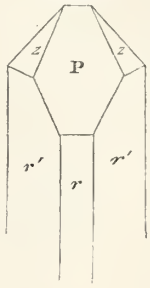
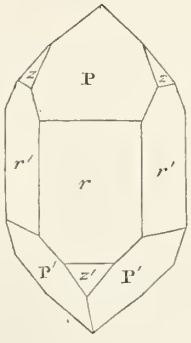


Fig. 147.



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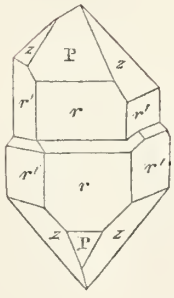


Fig. 149.

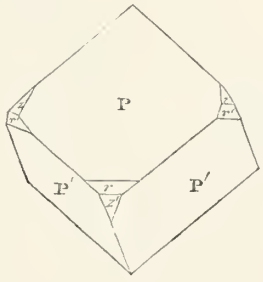
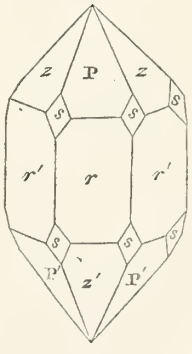


Fig. 150.



QUARTZ. (Continued.)

Fig. 152.

P on *a*	145°	22′
P on *c*	165	30
a on *c*	159	50
a on *e*	175	30
a on *z*	137	51
a on *z*″	111	15
e on *z*	145	30

Figs. 157, 158, 159, 160.

P on *a*	145°	22′
P on *c*	165	0
P on *t*	154	0

QUARTZ.

P″ on *t*	103	50
a on *z*	137	51
e on *z*	145	0
r on *t*	133	50
t on *z*	155	0

Fig. 161. A twin from Middleville, Herkimer county.

Fig. 161 (*bis.*) Two crystals crossing each other. It may be accidental.

Fig. 162.

P on *z*′ or P′ on *z* .... 103° 20′

Fig. 151.

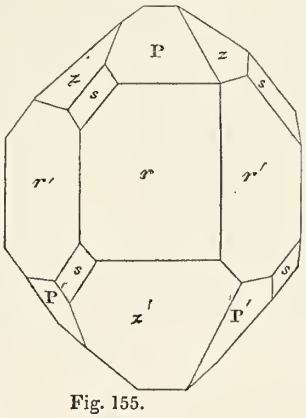


Fig. 152.

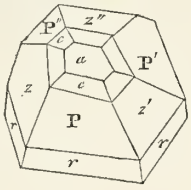


Fig. 153.

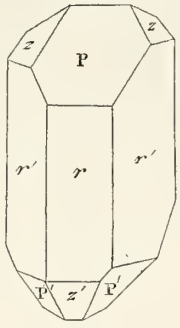


Fig. 154.

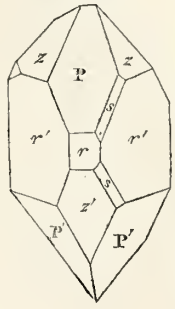


Fig. 155.

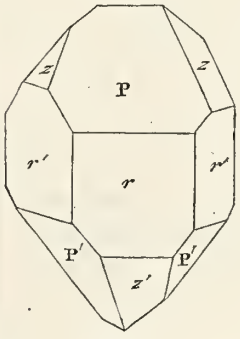


Fig. 156.

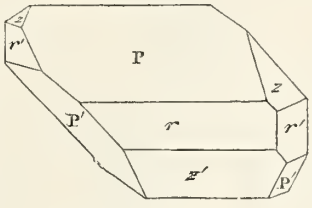


Fig. 157.

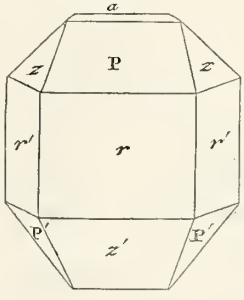


Fig. 158.

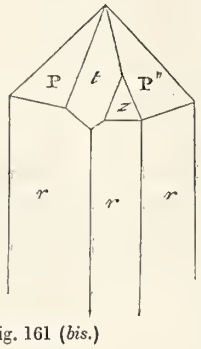


Fig. 159.

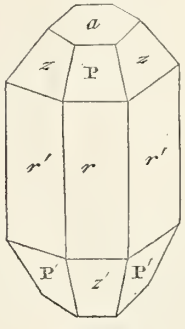


Fig. 160.

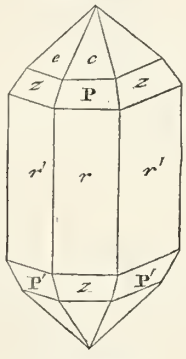


Fig. 161.

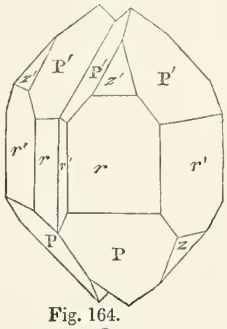


Fig. 161 (*bis.*)

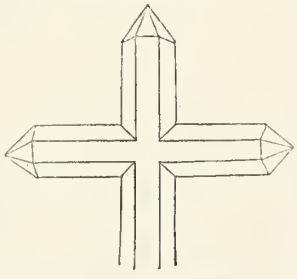


Fig. 162.

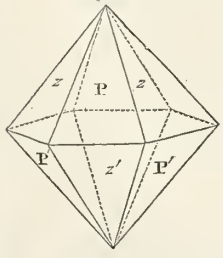


Fig. 163.

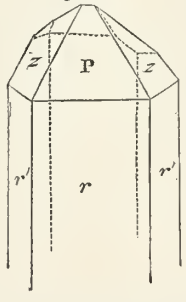


Fig. 164.

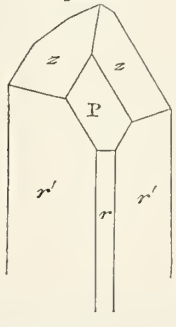


Fig. 165.

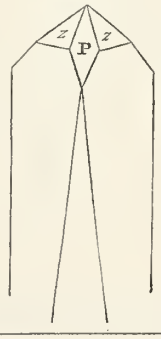
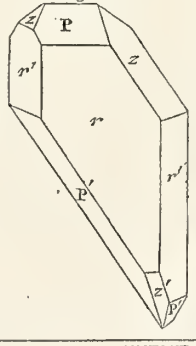


Fig. 166.



QUARTZ. (Continued.)

Figs. 167, 168 and 173, twin crystals.

Figs. 174, 175.

P on *o* ..... 128°20′

Fig. 181.

P on *x* ..... 148°42′

r on *x* 167 56

x on *z* 125 11

Fig. 167.

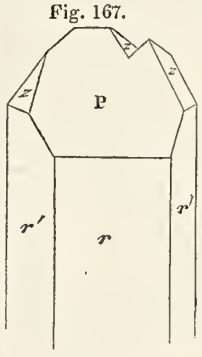


Fig. 168.

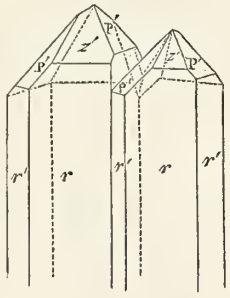


Fig. 169.

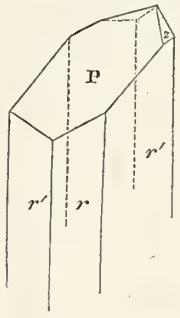


Fig. 170.

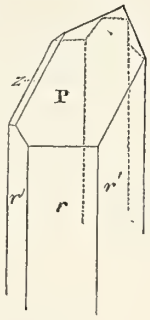


Fig. 171.

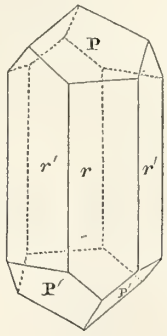


Fig. 172.

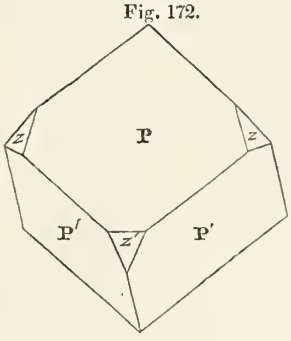


Fig. 173.

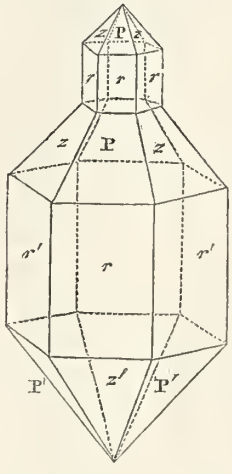


Fig. 174.

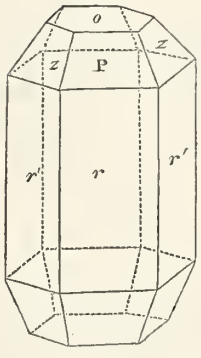


Fig. 175.

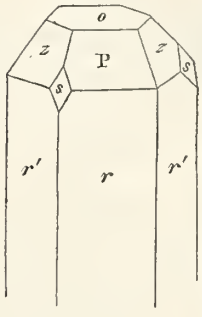


Fig. 176.

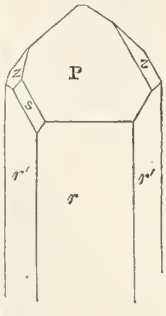


Fig. 177.

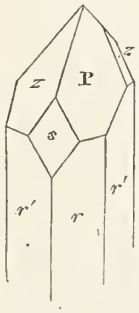


Fig. 178.

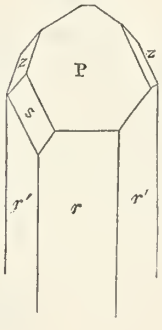


Fig. 179r

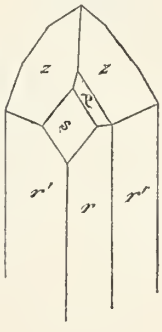


Fig. 180.

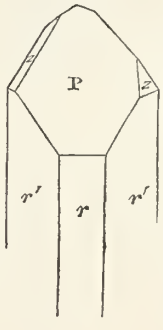
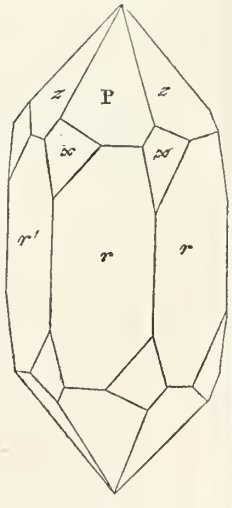


Fig. 181.



QUARTZ. (Continued.)

Fig. 182.

P on *f* or *z* on *f* ..... 141°40′

Fig. 183.

P on *o* ..... 160°15′

o on *o* 125 10

TABULAR SPAR. Fig. 184. Page 270.

Fig. 184. The primary, a right rhombic prism?

M on M′ ..... 95°20′

SERPENTINE. Figs. 185 to 189 inclusive. Page 272.

Fig. 185. The primary, a right rectangular prism. The remaining figures are secondary forms, but the angles have not been determined.

CHONDRODITE. Fig. 190. Page 281.

Fig. 190. The primary, a right oblique prism, the greater angles being 112° 12′.

TALC. Fig. 191. Page 284.

Fig. 191. The primary, a right rhombic prism.

M on M′ ..... 120° 0′

PYROXENE. Figs. 192 to 223 inclusive. Page 286.

Fig. 192. The primary, an oblique rhombic prism.

M on M′ ..... 87° 5′

M or M′ on P 100°10′ or 100 25

Fig. 193, et seq.

M or M′ on *r* ..... 133°35′

M′ on *l* 136 15

M on *o* 145 9

M or M′ on *s* 121 48

P on *r* 106 15

P on *s* 150 0

P on *t* 147 48

o on *o* 95 28

o on *r* 118 59

o on *s* 156 39

r on *u* 126 36

s on *s* 120 38

u on *u* 131 8

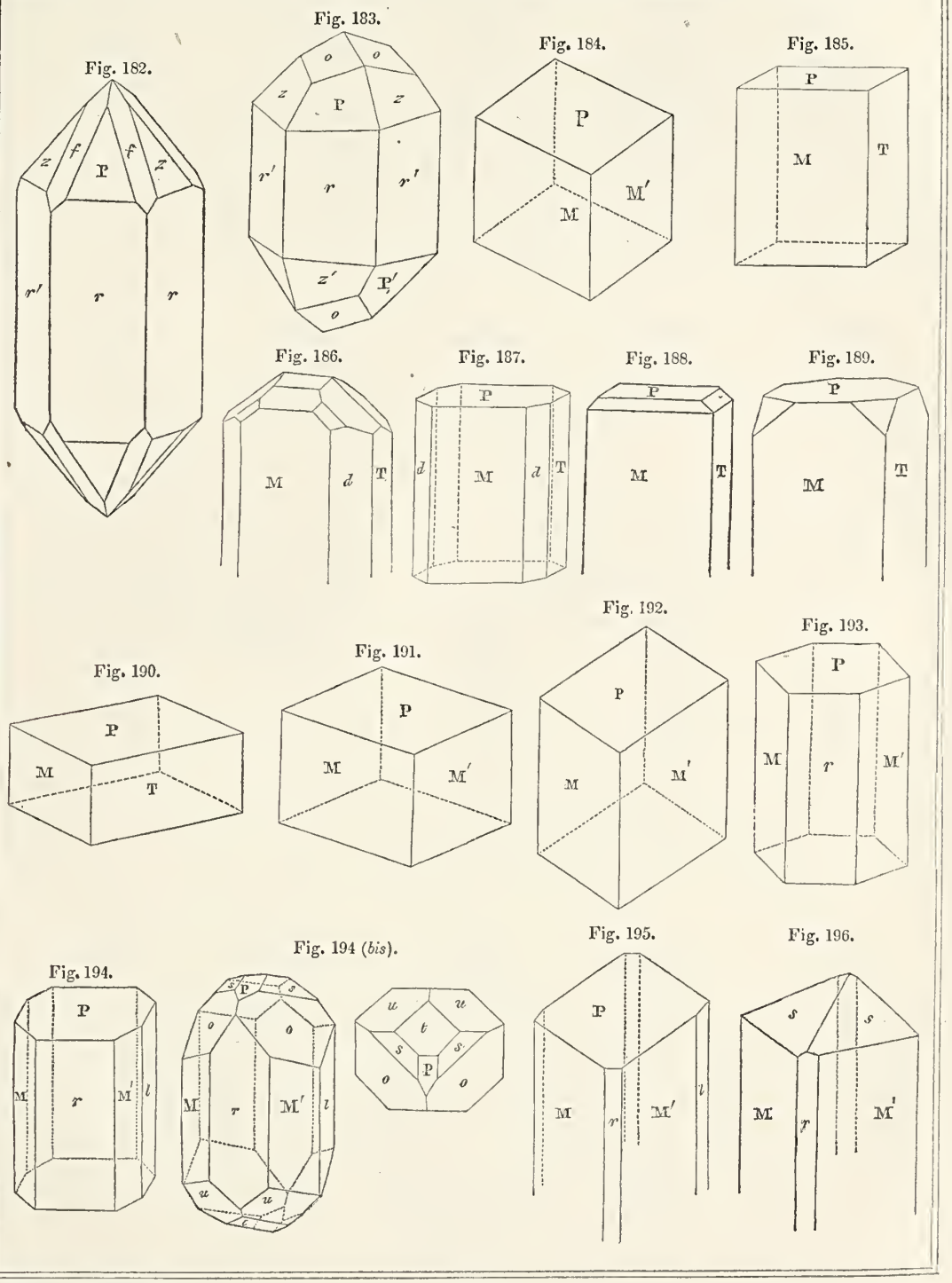


Fig. 182.
z f P f z
r' r r
Fig. 183.
o o
z P z
r' r r'
z' P'
o
Fig. 184.
P
M' M
Fig. 185.
P
M T
Fig. 186.
M d T
Fig. 187.
P
d M d T
Fig. 188.
P
M T
Fig. 189.
P
M T
Fig. 190.
P
M T
Fig. 191.
P
M M'
Fig. 192.
P
M M'
Fig. 193.
P
M r M'
Fig. 194.
P
M r M' l
Fig. 194 (bis).
s P s
o o
M r M' l
u u
u u t
s s
o P o
Fig. 195.
P
M r M' l
Fig. 196.
s s
M r M'

PYROXENE. (Continued.)

M on x	134°	17′
i on l	139	7
l on r	90	0
l on x	114	26
r on t	106°	6′
r on x	126	36
x on x	131	8

(The remaining measurements will be found on page 284.)

Fig. 197.

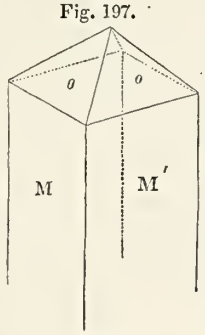


Fig. 198.

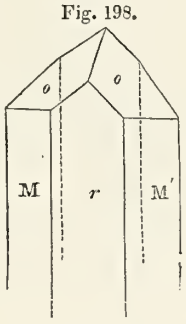
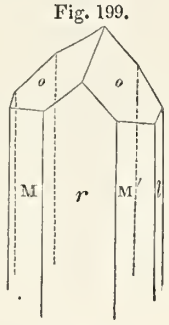


Fig. 199.



Fig, 200.

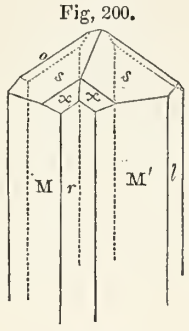


Fig. 201.

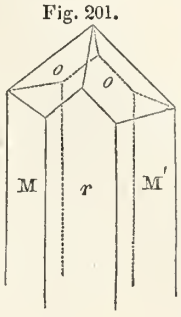


Fig. 202.

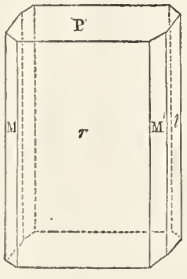


Fig. 203.

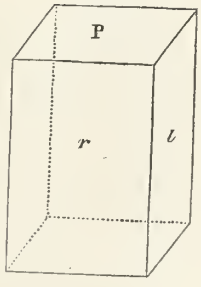


Fig. 204.

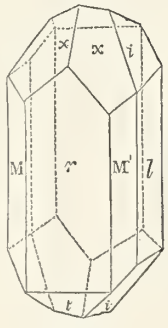


Fig. 205.

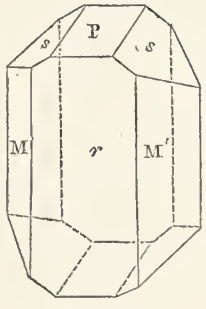


Fig. 206.

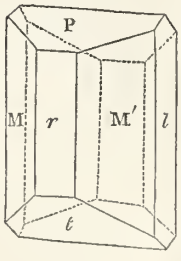


Fig. 207.

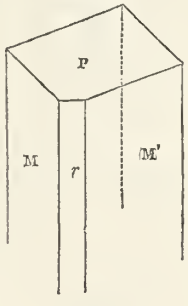


Fig. 208.

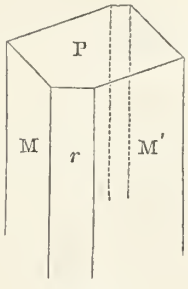


Fig. 209.

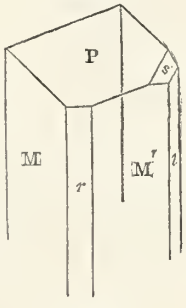


Fig. 210.

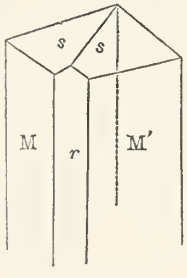


Fig. 211.

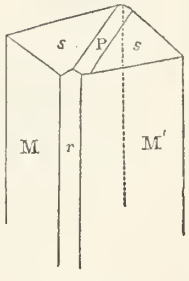


Fig. 212.

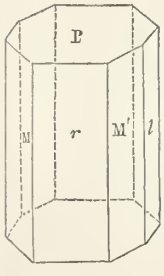


Fig. 213.

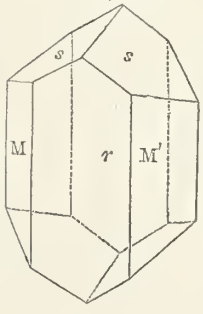


Fig. 214.

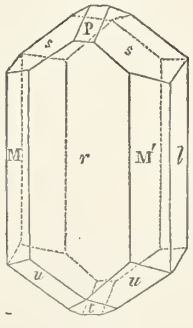


Fig. 215.

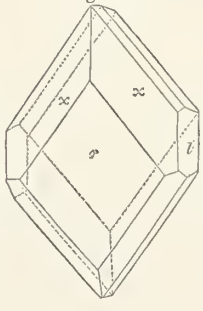
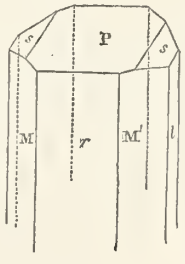


Fig. 216.



PYROXENE. (Continued.)

Figs. 218 and 219. Twins from Putnam county.

Fig. 220, et seq.

M on *o*	145°	9′
M on *x*	134	17
l on *x*	114	26
r on *t*	106	6
r on *x*	126	36
x on *x*	131	8
u on *u*	131	8

HORNBLENDE. Fig. 223 (*bis*) to 250 inclusive. Page 298.

Fig. 223 (*bis*). The primary, an oblique rhombic prism.

HORNBLENDE.

M on M′	124°	30′
M or M′ on P	103	1

Fig. 224, et seq.

M on *s*	152°	17′
M′ on *x*	117	43
k on *k* *	155	4
k on *x*	102	22
l on *l*	110	2
l on *x*	105	11
i on *x*	129	8
r on *r*	149	38
r on *x*	105	11

* Incorrectly 55° 4′ on page 301.

Fig 217.

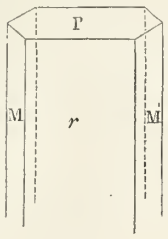


Fig. 218.

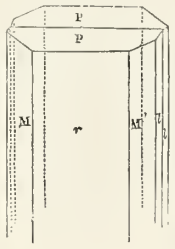


Fig. 219.

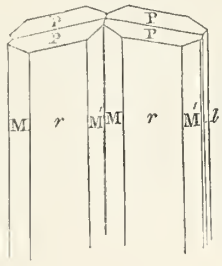


Fig. 220.

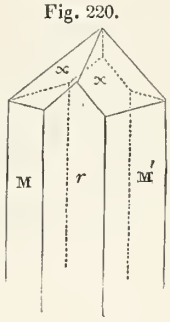


Fig. 221.

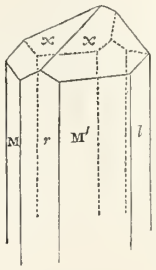


Fig. 222.

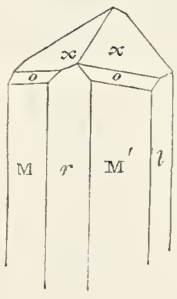


Fig. 223.

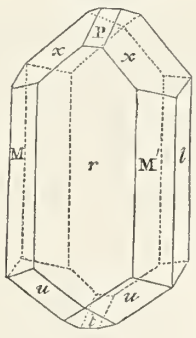


Fig. 223 (*bis.*)

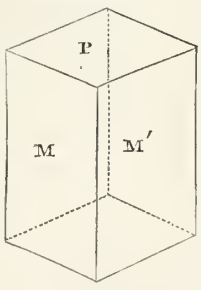


Fig. 224.

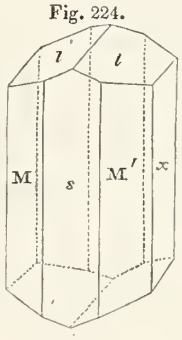


Fig. 225.

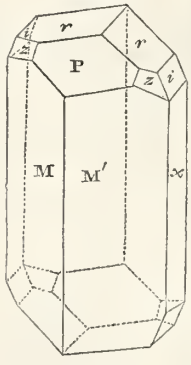


Fig. 226.

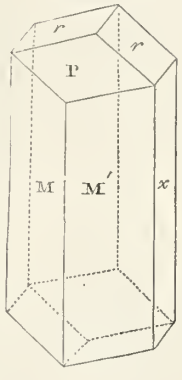


Fig. 227.

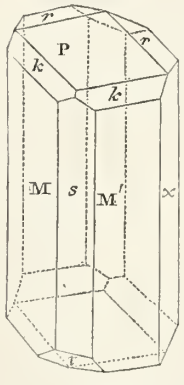


Fig. 228.

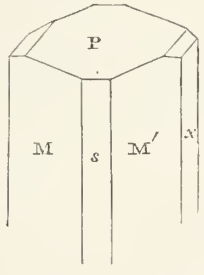


Fig. 229.

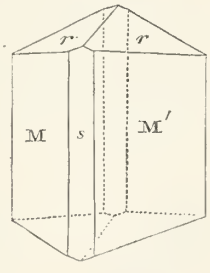


Fig. 233.

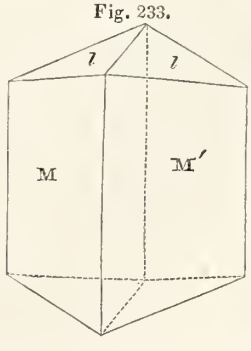


Fig. 230.

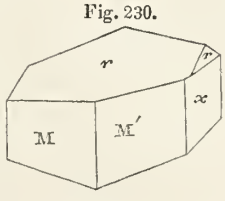


Fig. 231.

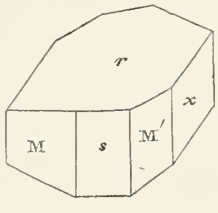
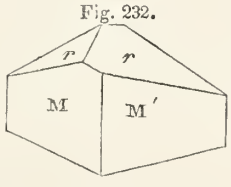


Fig. 232.



HORNBLENDE. (Continued.)

Fig. 245.

P on *o* ..... 152°30′

Fig. 246.

x on *z* ..... 118°28′

Fig. 248.

P on *l* ..... 164°49′

(The remaining measurements will be found on page 488.)

ARFWEDSONITE. Fig. 251. Page 309.

Fig. 251. The primary, an oblique rhombic prism?

M on M′ ..... 123°55′

CORUNDUM. Figs. 252 to 254 inclusive. Page 314.

Fig. 252. The primary, a rhombohedron.

P on P′ ..... 93°54′

Fig. 253, a secondary form of the same mineral.

Fig. 234.

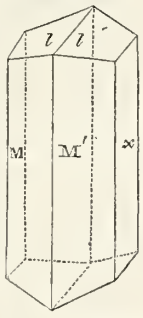


Fig. 235.

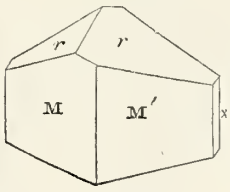


Fig. 236.

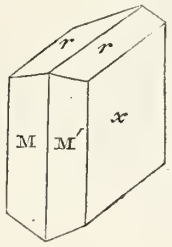


Fig. 237.

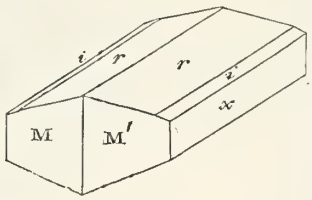
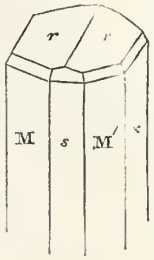


Fig. 238.



Fig, 239.

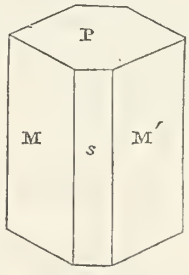


Fig. 240.

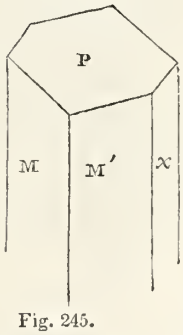


Fig. 241.

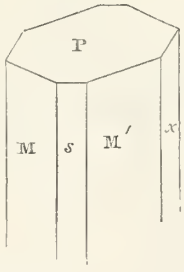


Fig. 242.

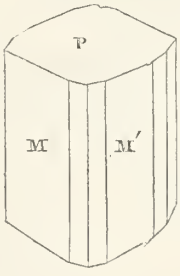


Fig. 243.

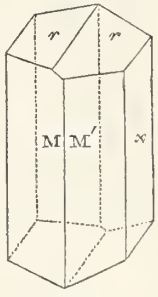


Fig. 244.

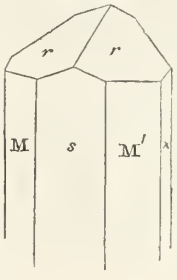


Fig. 245.

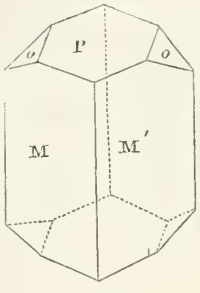


Fig. 246.

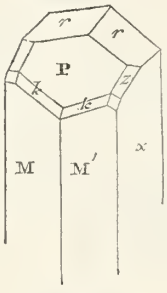


Fig. 247.

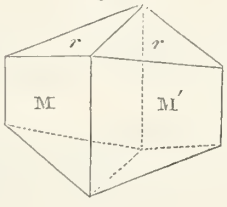


Fig. 248.

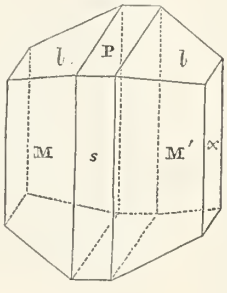
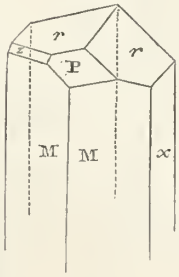


Fig. 249.



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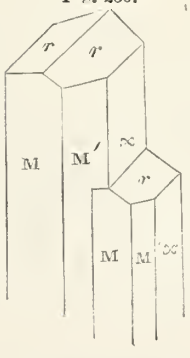

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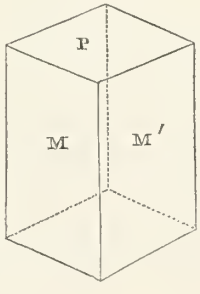

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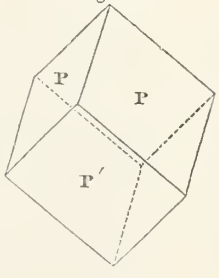

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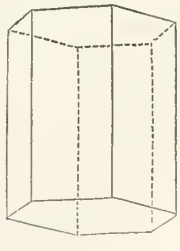


CORUNDUM. (Continued.)

Fig. 254, a secondary form.

SPINELLE. Figs. 255 to 264 inclusive. Page 315.

Fig. 255. The primary, a regular octahedron.

P on P′ ..... 109°28′ 16″

Figs. 256 and 257.

P on *o* ..... 144°48′ 8″

o on *o* 120 0 0

Figs. 260 and 261. Groups of crystals, Orange county.

Fig. 262. A twin consisting of two equal and similar portions of a crystal similar to 256.

Fig. 263. A twin composed of about equal parts of the primary octahedron, of which one half is turned round.

SPINELLE.

Fig. 264. Three nearly equal parts of the same crystal variously turned upon each other. The faces of composition in the latter case project.

AUTOMOLITE. Fig. 265. Page 319.

Fig. 265. The primary, a regular octahedron.

P on P′ ..... 109°28′16″

IDOCRASE. Figs. 266 to 269 inclusive. Page 321.

Fig. 266. The primary, a right square prism.

Figs. 267 and 268.

M on *c* ..... 115°15′

M on *d* 135 0

P on *c* 142 54

c on *d* 127 6

Fig. 254.

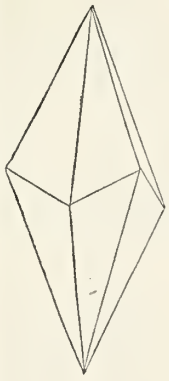
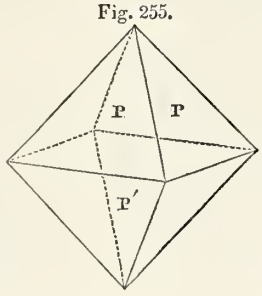


Fig. 255.



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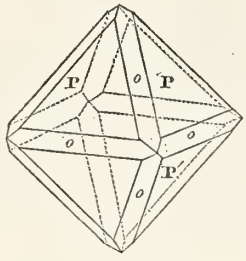


Fig. 257.

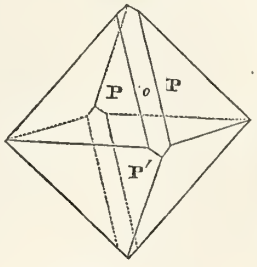


Fig. 258.

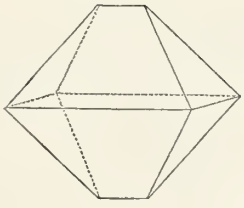


Fig. 259.

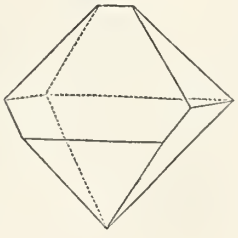
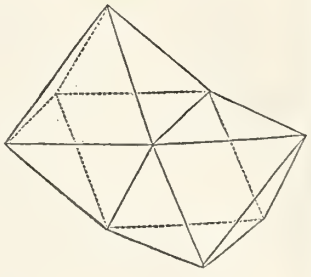


Fig. 260.



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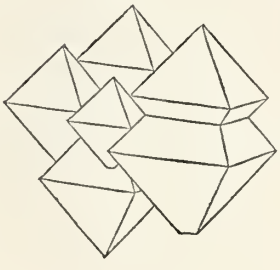
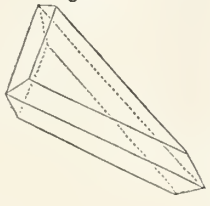


Fig. 262.



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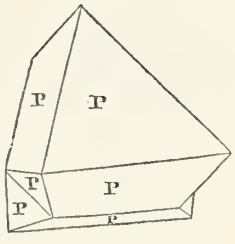
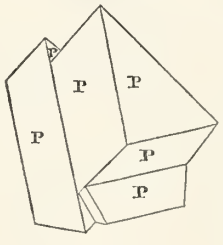


Fig. 264.



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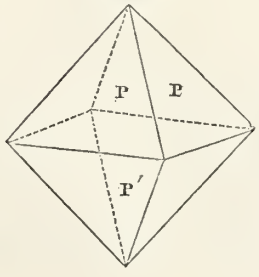
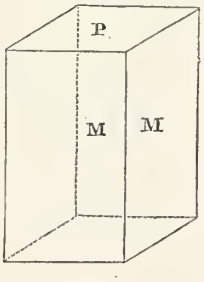


Fig. 266.



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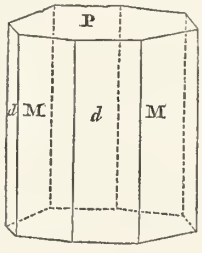

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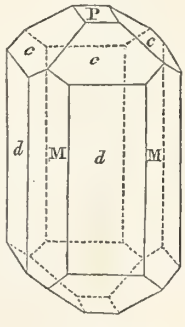


DOCRASE. (Continued.)

Fig. 269.

c on *d*	127°6′

GARNET. Figs. 270 to 278 inclusive. Page 323.

Fig. 270. The primary, a rhombic dodecahedron.

P on P	120° 0′ 0″

Fig. 271.

P on *n* or *n*′	150° 0′ 0″
n on *n* or *n*′ on *n*′	131 48 56
n on *n*′	146 26 33

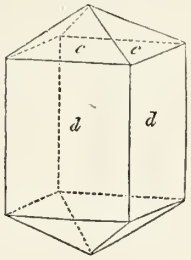
SCAPOLITE. Figs. 279 to 299 inclusive. Page 329.

Fig. 279. The primary, a right square prism.

Fig. 280, et seq.

M on *l*	112°30′
M on *s*	135 0
M on *t*	113 34
M on *z*	140 11
l on *l*	136 22
l on *s*	122 10
l on *t*	158 11
l on *z*	151 38
z on *z*	150 18

Fig. 269.



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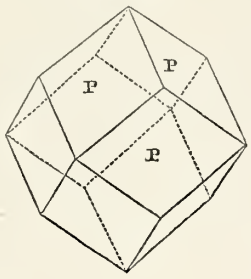

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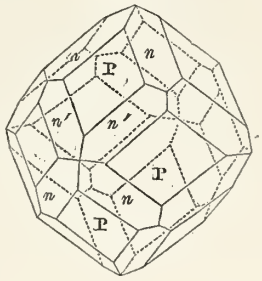

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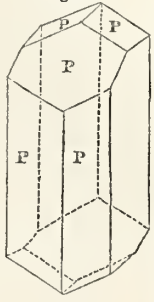

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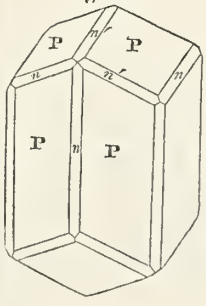

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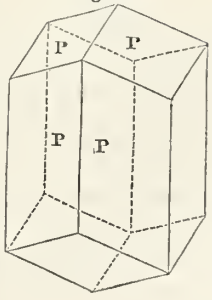

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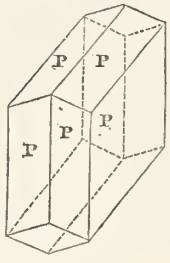

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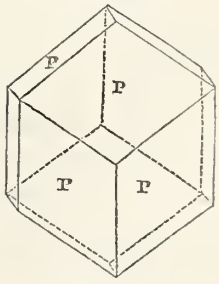

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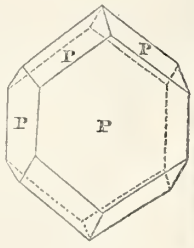

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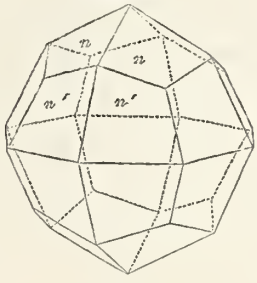

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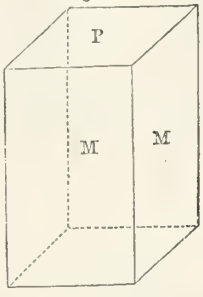

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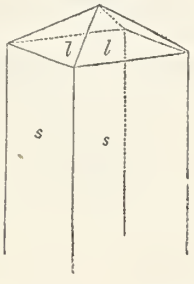

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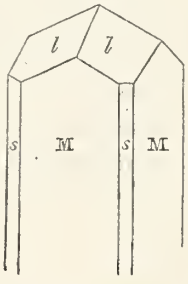

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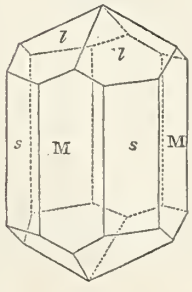

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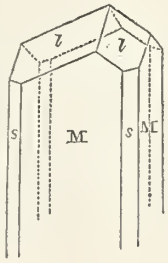

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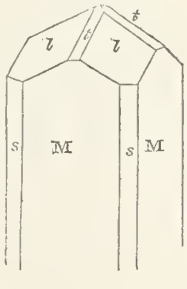

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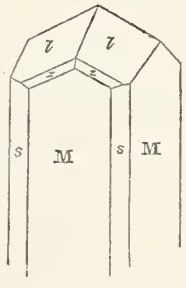

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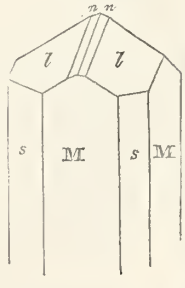


SCAPOLITE. (Continued.)

Fig. 288.

M on x	153°26′
M on z	140 11
s on x	161 34
z on z	150 18

(The remaining measurements will be found on page 494.)

STAUROLITE. Figs. 300 to 304 inclusive. Page 333.

Fig. 300. The primary, a right rhombic prism.

M on M′	129°30′
M or M′ on P	90 0

STAUROLITE.

Figs. 301, 302, 303.

M′ on o	115°18′
M or M′ on r	137 58

Fig. 304. Two crystals forming a cross.

FELDSPAR. Figs. 305 to 323 inclusive. Page 334.

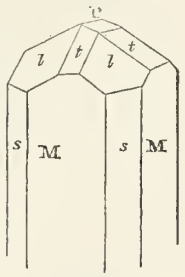
Fig. 305. The primary, a doubly oblique prism.

M on T	120°35′
P on M	90 0
P on T	67 15

Fig. 306.

M on l	120° 0′

Fig. 287.



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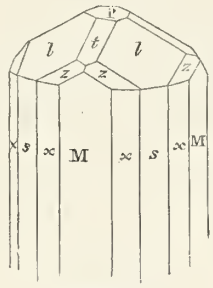

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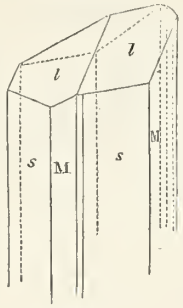

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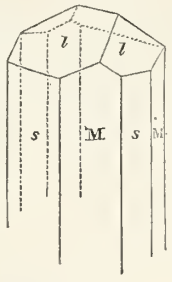

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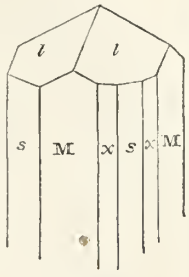

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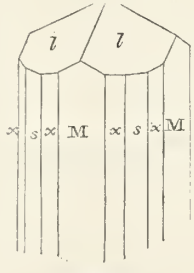

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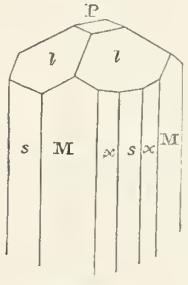

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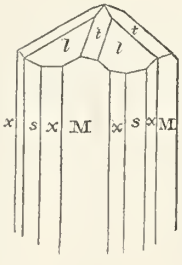

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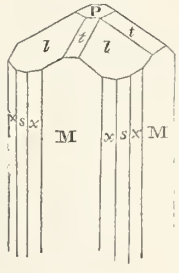

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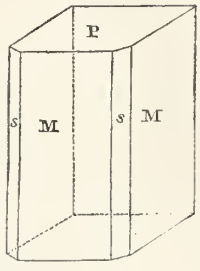

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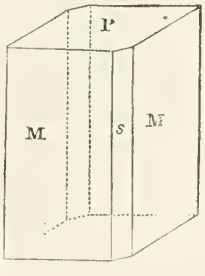

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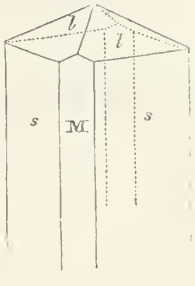

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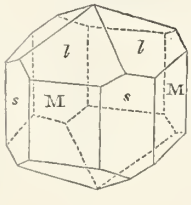
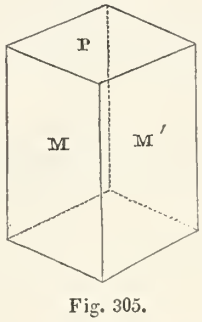


Fig 300.



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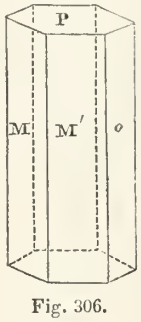

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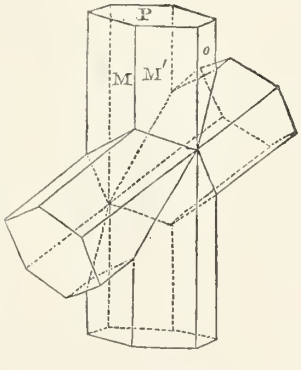

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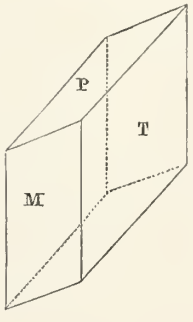

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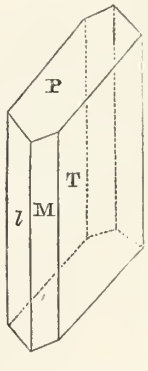

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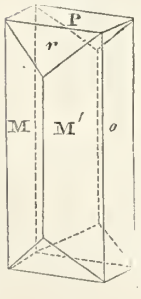

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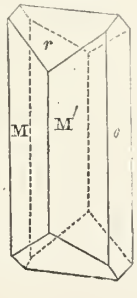


FELDSPAR. (Continued.)

Figs. 307 and 308.

M on *s*	116°20′
M on *y*	90 0
P on *l*	111 40
P on *s*	124 10
P on *y*	99 29

Fig. 309. A compound crystal from New-York.

Fig. 311.

M on *x*	90° 0′
P on *x*	128 51

FELDSPAR.

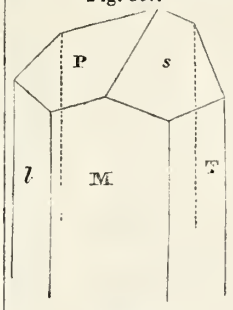
Fig. 312. A twin from Orange county.

Fig. 315 and 316.

M on *n*	135° 0′
M on *q*	90 0
M on *z*	150 0
T on *z*	150 0
q on *x*	164 40

Figs. 318 and 319. Twins from Hammond, St. Lawrence county.

Fig. 307.



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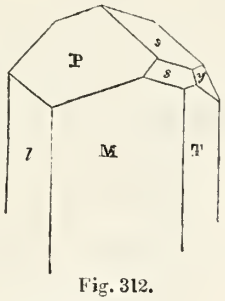

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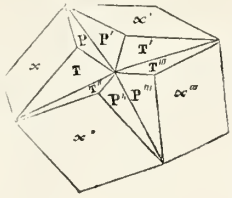

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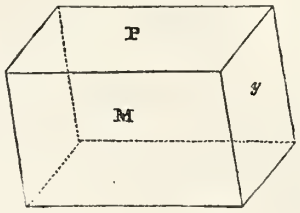

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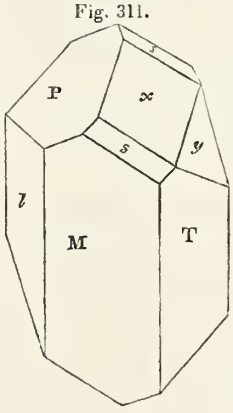

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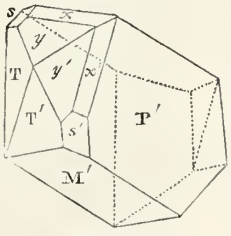


Fig. 313.

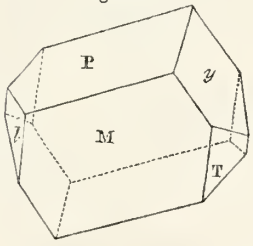
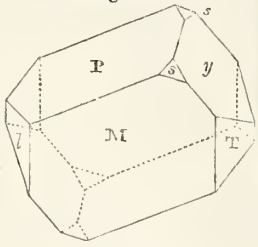


Fig. 314.



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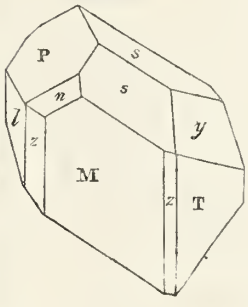

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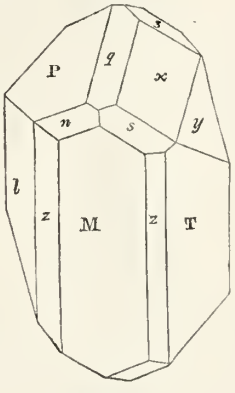
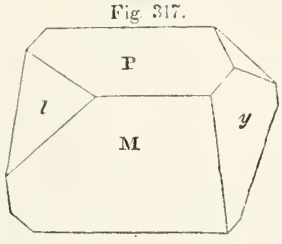


Fig. 317.



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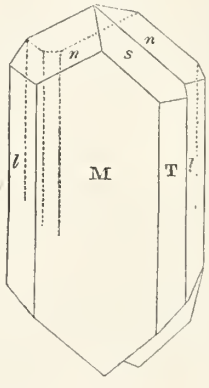

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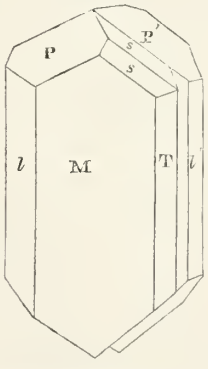

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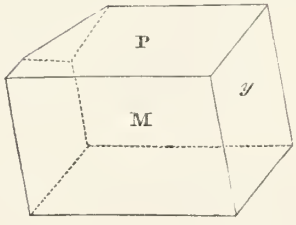

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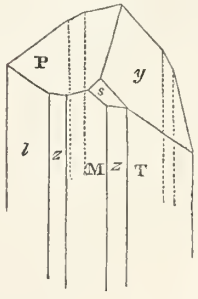


FELDSPAR. (Continued.)

(The measurements will be found on pages 496 and 498.

LABRADORITE. Fig. 324. Page 341.

Fig. 324. The primary, a doubly oblique prism.

M on P	94°30′
M on T	115 0
P on T	119 0

ALBITE. Fig. 325. Page 342.

Fig. 325. The primary, a doubly oblique prism.

M on P	93°30′
M on T	117 53
P on T	115 5

MESOTYPE. Figs. 326 to 329 inclusive. Page 344.

Fig. 326. The primary, a right rhombic prism.

M on M′	91°10′ to 91°40′

Fig. 327, et seq.

M on *o*	116°32′
o on *o*	144 16

STILBITE. Figs. 330 to 333 inclusive. Page 345.

Fig. 330. The primary, a right rectangular prism.

STILBITE.

Fig. 331.

M on *d*	133°30′

HEULANDITE. Figs. 334 to 336 inclusive. Page 346.

Fig. 334. The primary, a right oblique angled prism.

M on T	130° 0′
P on T	90 0

Figs. 335 and 336.

M on *a*	146°30′
M on *f*	114 20
P on *a*	111 56
T on *a*	148 0

EPISTILBITE. Figs. 337 and 338. Page 347.

Fig. 337. The primary, a right rhombic prism.

M on M′	135°10′

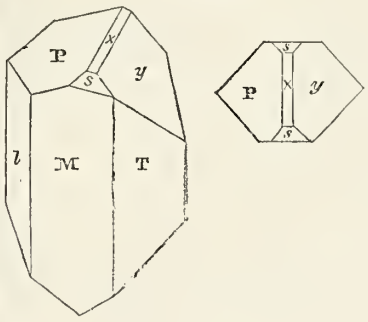
Fig. 338.

M or M′ on *t*	122° 9′
s on *t*	141 47
t on *t*	109 46
t on *u*	154 51

APOPHYLLITE. Figs. 339 to 342 inclusive. Page 348.

Fig. 339. The primary, a right square prism.

Fig. 322.



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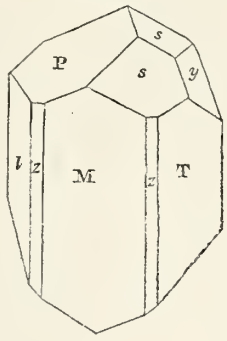

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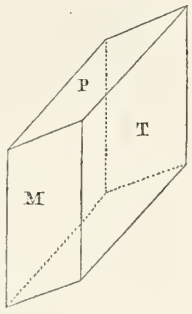

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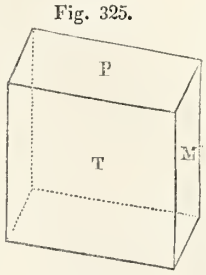

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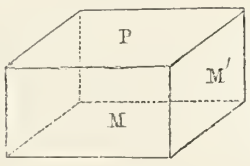

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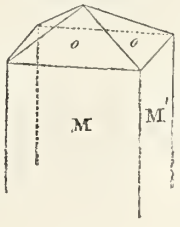

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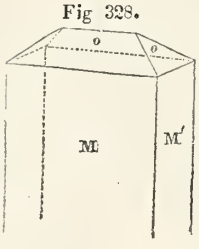

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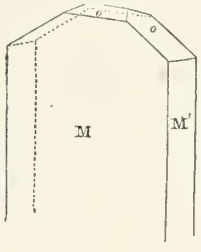

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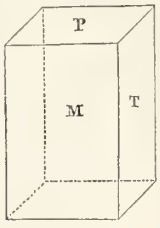

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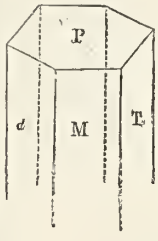
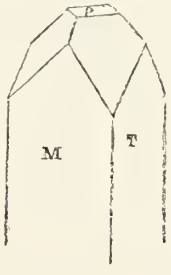


Fig. 332.

Fig. 333.



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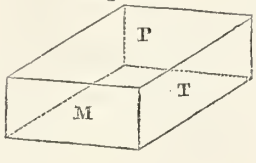

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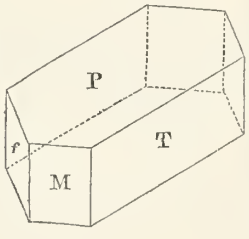

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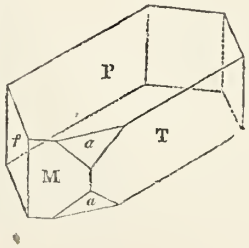
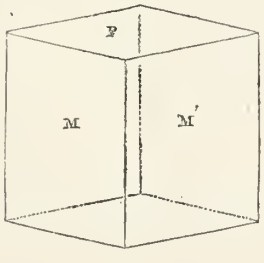


Fig. 337



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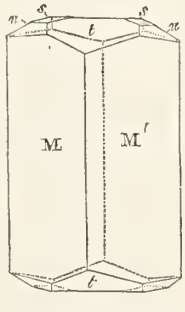
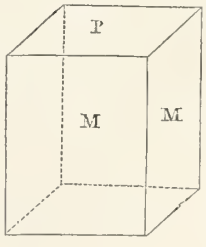


Fig. 339.



APOPHYLLITE. (Continued.)

M on M	90° 0′
M on P	90 0
M on *s*	128 20
P on *s*	120 5
s on *s*	104 18

PREHNITE. Fig. 343. Page 349.

Fig. 343. The primary, a right rhombic prism.

M on M′ ... 100°0′ or 102°30′

THOMPSONITE. Fig. 344. Page. 350.

Fig. 344. The primary, a right square prism.

LAUMONITE. Fig. 345. Page 351.

Fig. 345. The primary, an oblique prism.

M on M′	86°15′
M on P	113 30

ANALCIME. Figs. 346 to 348 inclusive. Page 352.

Fig. 346. The primary, a cube.

CHABAZITE. Fig. 349. Page 353.

Fig. 349. The primary, an obtuse rhombohedron.

P on P″ ..... 94°46′

EPIDOTE. Figs. 350 to 355 inclusive. Page 354.

Fig. 350. The primary, a right oblique angled prism.

M on T ... 114°37′ to 115°30′

Fig. 351, et seq.

M on *o*	121°23′
M on *r*	116 40
P on *n*	144 35
P on *o*	148 37
P on *u*	125 35
n on *n*	109 10
n on *r*	125 25

Fig. 340.

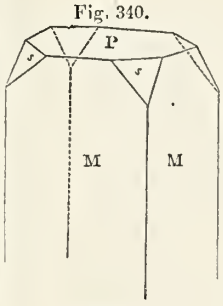
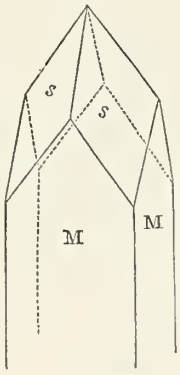


Fig. 341.



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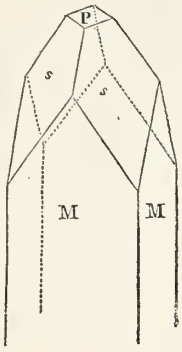

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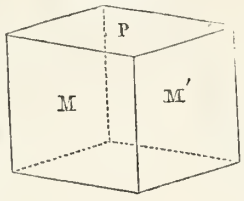

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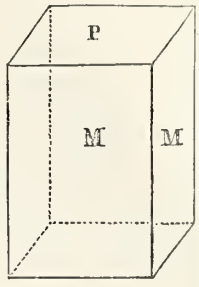

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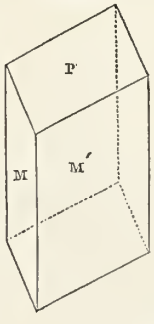

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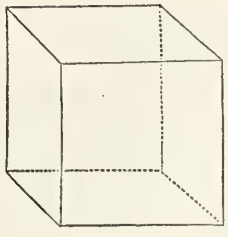

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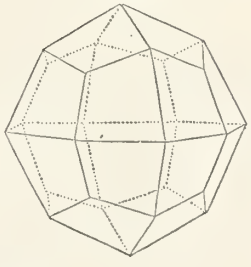
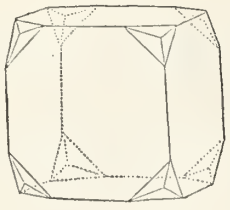


Fig. 348.



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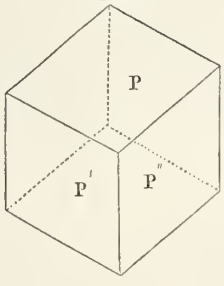
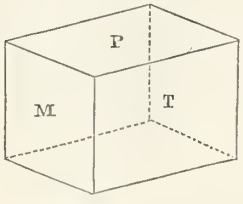


Fig. 350.



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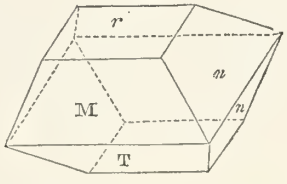

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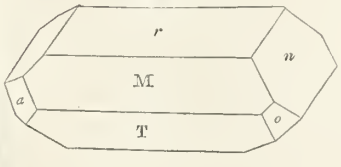

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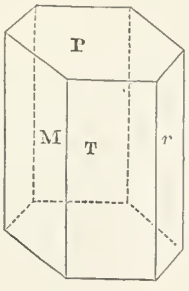

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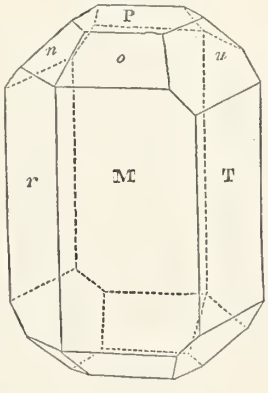
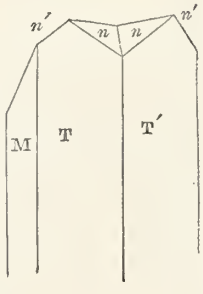


Fig. 355.



TOURMALINE. Figs. 356 to 373 inclusive. Page 356.

Fig. 356. The primary, an obtuse rhombohedron.

P on P	133°26′

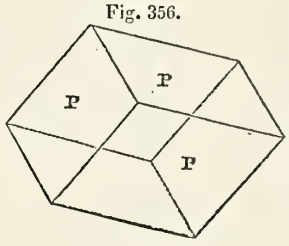
Fig. 357, et seq.

P on *k*	152°51′
P on *l*	117 9
P on *n*	156 43
P on *o*	141 40
P on *s*	113 13

TOURMALINE.

k on *l*	90° 0′
k on *s*	90 0
l on *l*	120 0
l on *o*	135 44
l on *s*	150 0
n on *n*	155 9
n on *s*	102 26
o on *o*	103 20
s on *s*	120 0

Fig. 356.



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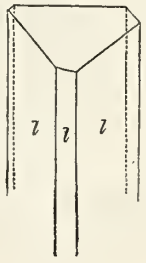

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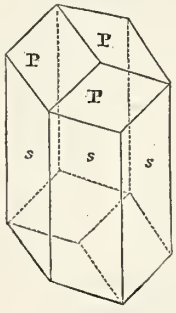

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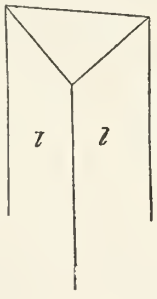

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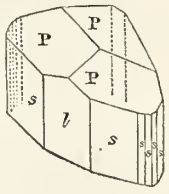


Fig. 361.

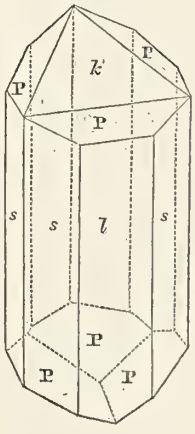


Fig. 362.

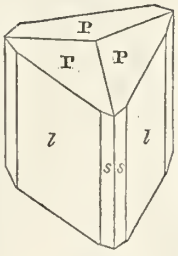


Fig. 363.

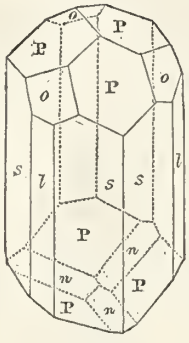
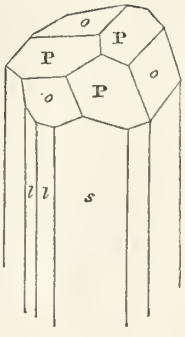


Fig. 364.



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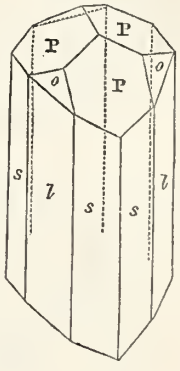

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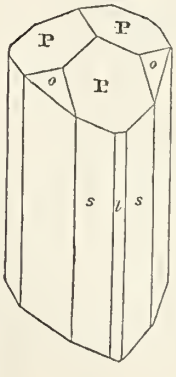
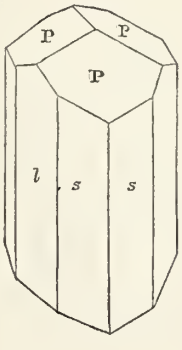


Fig. 367.



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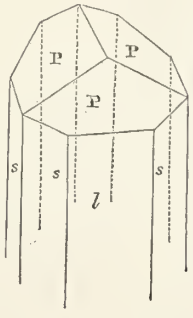
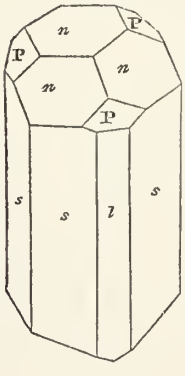


Fig. 369.



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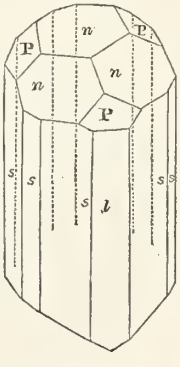


TOURMALINE. (Continued.)

Figs. 371, 372 and 373. (The measurements will be found on page 504.)

CLINTONITE. Figs. 374 to 376 inclusive. Page 361.

Fig. 374. The primary, an oblique rhombic prism.

M on M′ about ..... 94° 0′

ANDALUSITE. Figs. 377 to 380 inclusive. Page 362.

Fig. 377. The primary, a right rhombic prism.

M on M′ ..... 91° 20′

KYANITE. Fig. 381. Page 365.

Fig. 381. The primary, a doubly oblique prism.

M on T ..... 106°15′
P on M 93 15
P on T 100 50

ACHMITE. Figs. 382 and 383. Page 366.

Fig. 382. The primary, an oblique rhombic prism.

M on M′ ..... 93° 4′

Fig. 383. A secondary form of the above.

SPODUMENE. Fig. 384. Page 368.

Fig. 384. The primary, an oblique rhombic prism.

M on M′ ..... 93° 0′

Fig. 371.

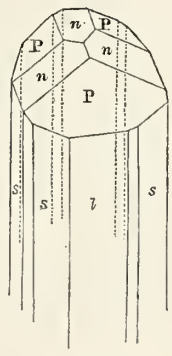


Fig. 372.

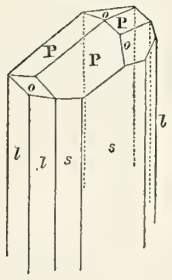
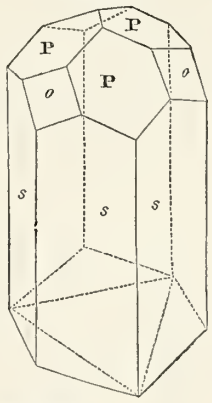


Fig. 373.



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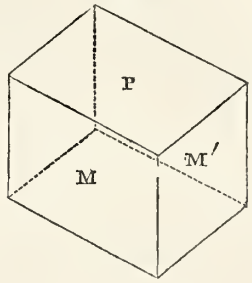

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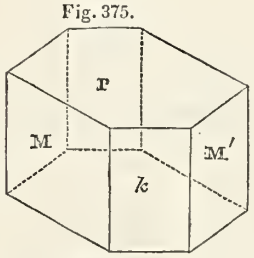
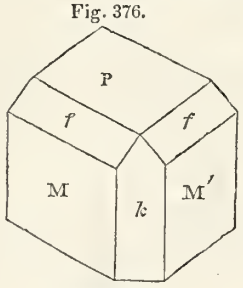


Fig. 376.



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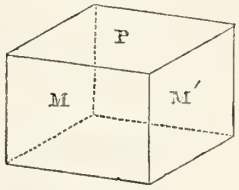

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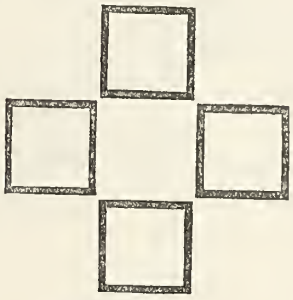

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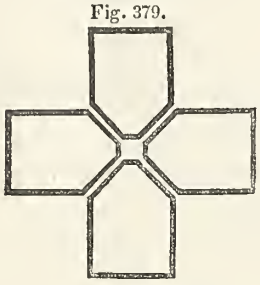
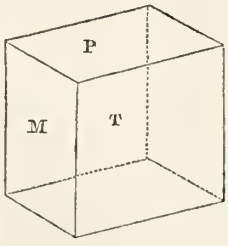


Fig. 380.

Fig. 381.



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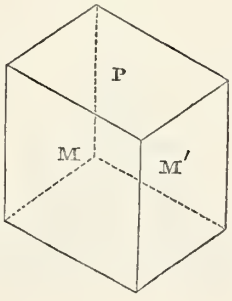


Fig. 383.

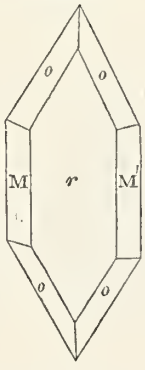
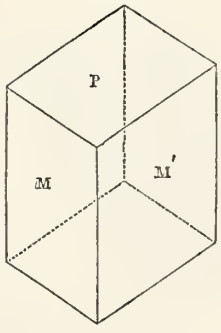


Fig. 384.



MICA. Figs. 385 to 396 inclusive. Page 369.

Fig. 385. Regular six-sided prism.
M on M ..... 120°0′
M on P 90 0

Fig. 386. An oblique rhombic prism, with transverse sections of about 120° and 60°.

Figs. 387, 390, 391, 392, 393, 394 and 396, various crystalline forms, the cleavages being represented by the dotted lines.

Fig. 388. A six-sided table from St. Lawrence county.
M or M′ on *k* ..... 120° 0′

Fig. 389. An oblique rhombic prism from Greenwood furnace, Orange county.
P on *a* ..... 114° to 115°
a on *a* ..... about 120° 0′

MICA.

Fig. 395.
M on *l* ..... 150°

EMERALD. Fig. 397. Page 374.

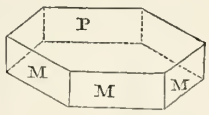
Fig. 397. The primary, a regular six-sided prism.

CHRYSOBERYL. Figs. 398 to 413 inclusive. Page 375.

Fig. 398. The primary, a right rectangular prism.

Figs. 399 and 400.
M on *s* ..... 125°16′
T on *s* 144 44
i on *i* 120 0

Fig. 385.



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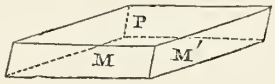


Fig. 387.

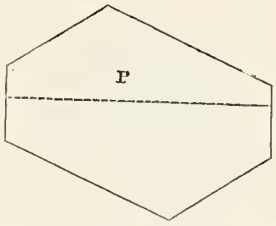


Fig. 388.

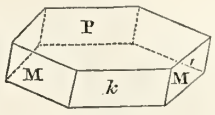


Fig. 389.

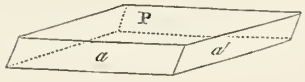


Fig. 390.

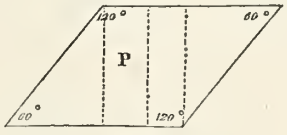


Fig. 391.

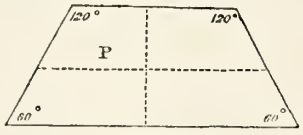


Fig. 392.

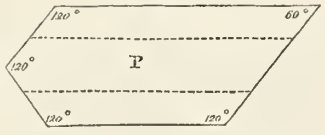


Fig. 393.

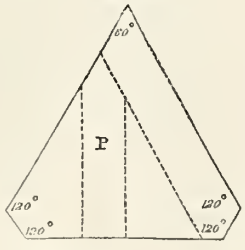


Fig. 394.

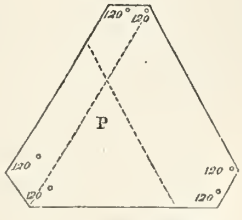


Fig. 395.

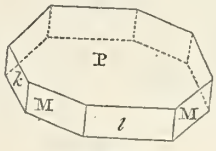
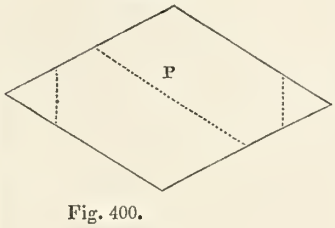


Fig. 396.



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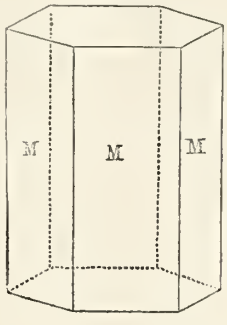

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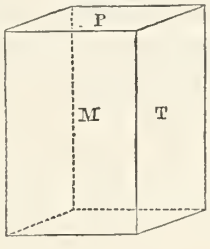

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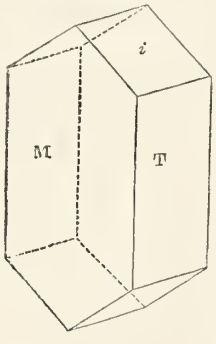


Fig. 400.

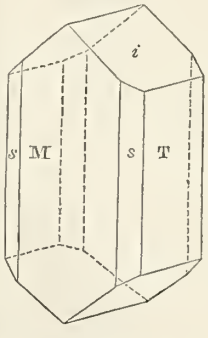


Fig. 401.

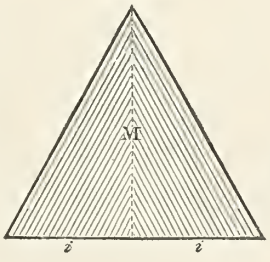


Fig. 402.

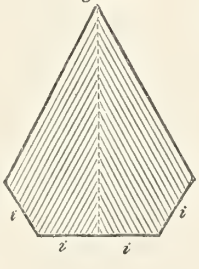
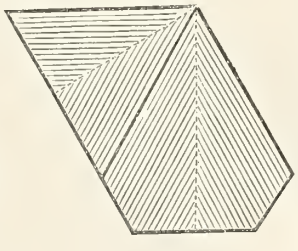


Fig. 403.



CHRYSOBERYL. (Continued.)

Figs. 404 to 413 inclusive, compound tabular crystals of various forms, the descriptions of which will be found on pages 376 and 377. (Fig. 404 is a dissected six-sided table, the striæ being represented only in the lower part.)

ZIRCONITE. Figs. 414 to 435 inclusive. Page 378.

Fig. 414. The primary, an obtuse octahedron with a square base.

ZIRCONITE.

P on P over the base, ... 84°20′

P on P over a pyramidal edge, 123 15

Figs. 415, et seq.

P on *l*	.....	131°49′
P on *u*	.....	152 8
P on *x*	.....	150 5
l on *l*	.....	90 0
l on *u*	.....	159 17
l on *x*	.....	142 55

Fig. 404.

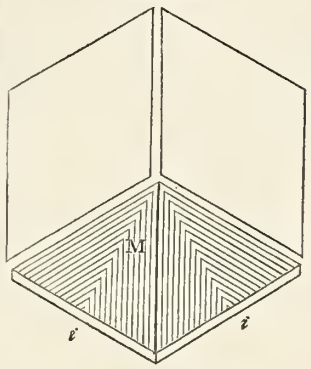


Fig. 405.

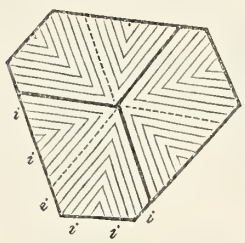


Fig. 406.

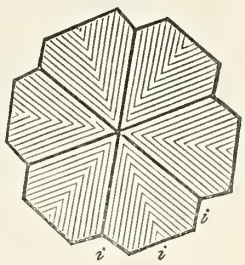


Fig. 407.

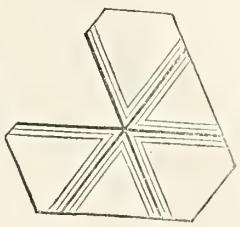


Fig. 408.

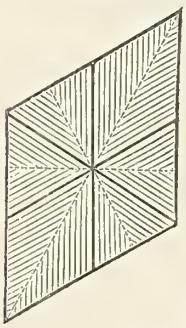


Fig. 409.

Fig. 410.

Fig. 411.

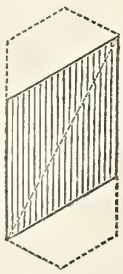


Fig. 412.

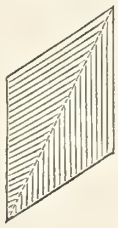


Fig. 413.

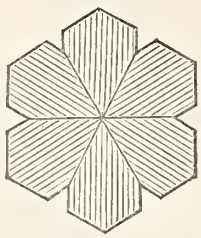


Fig. 414.

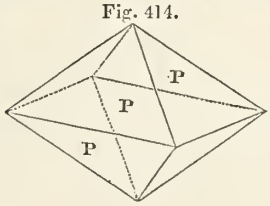


Fig. 415.

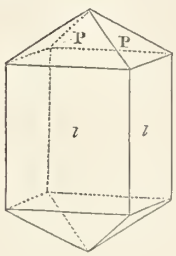


Fig. 416.

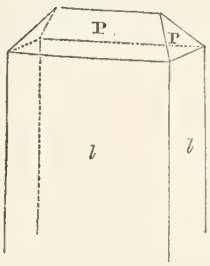


Fig. 417.

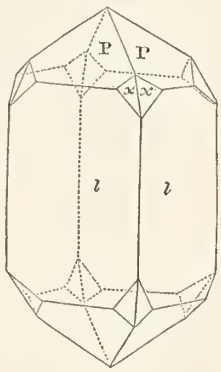


Fig. 418.

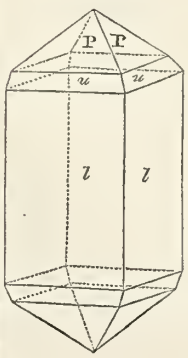


Fig. 419.

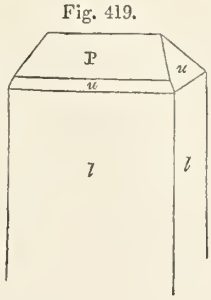


Fig. 420.

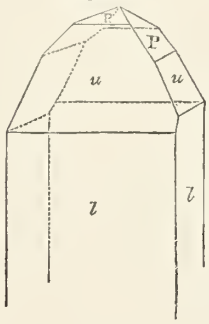


Fig. 421.

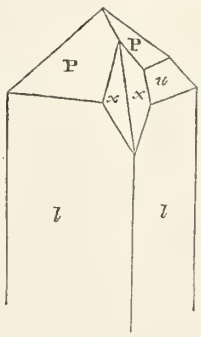
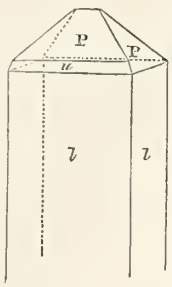


Fig. 422.



ZIRCONITE. (Continued.)

P on s ..... 117°48′
P on t 152 6
l on s 135 0

(The remaining measurements are given on page 510.)

NATIVE IRON. Fig. 436. Page 382.

Fig. 436. The primary, a regular octahedron.

MAGNETIC IRON ORE. Figs. 437 to 444 inclusive. Page 383.

Fig. 437. The primary, a regular octahedron.

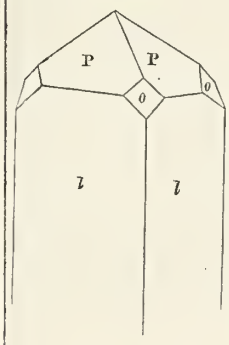
P on P′ ..... 109°28′16″

Fig. 438. A cuneiform octahedron from Essex county.

Figs. 439, et seq.

P on i ..... 125°15′52″

Fig. 423.



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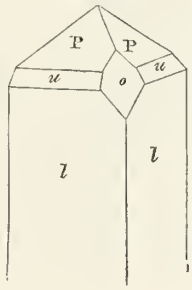


Fig. 425.

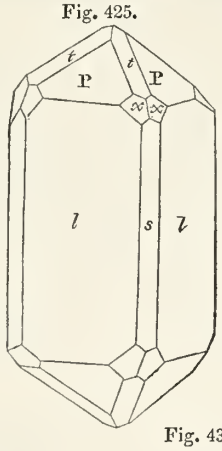


Fig. 426.

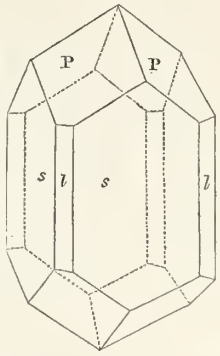


Fig. 427.

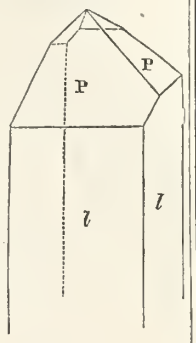


Fig. 428.

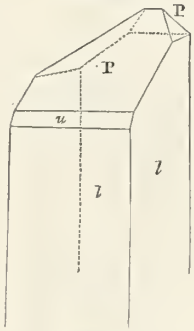


Fig. 429.

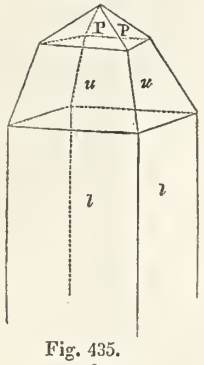
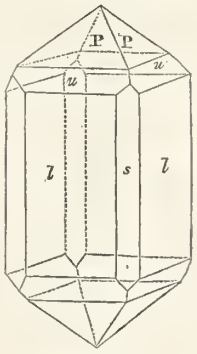


Fig. 430.



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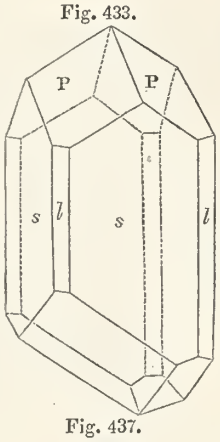

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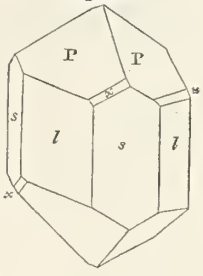


Fig. 435.

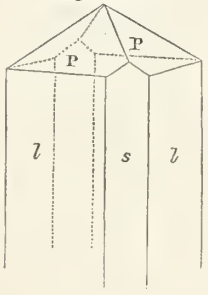


Fig. 436.

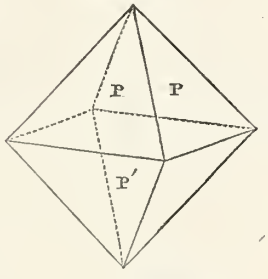


Fig. 437.

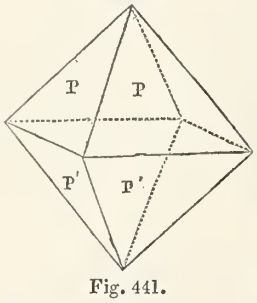


Fig. 438.

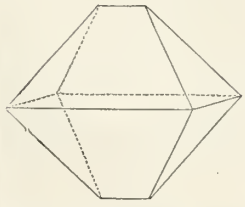
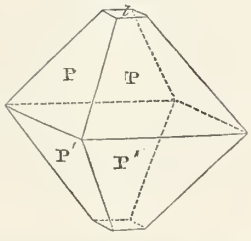


Fig. 439.



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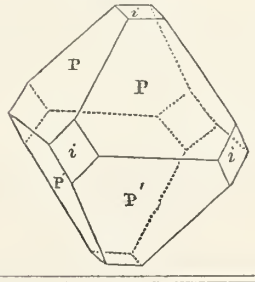
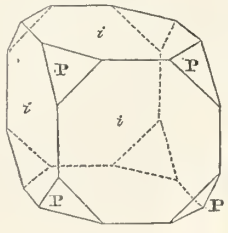


Fig. 441.



MAGNETIC IRON ORE. (Continued.)

Figs. 442, 443 and 444, secondary forms from Orange county.

SPECULAR IRON ORE. Figs. 445 to 447 inclusive. Page 385.

Fig. 445. The primary, a rhombohedron.
P on P ... 86° 10′ and 93° 50′

Fig. 446. A modification of a very obtuse rhombohedron (Fig. 447), forming a *lenticular* crystal, St. Lawrence county.

IRON PYRITES. Figs. 448 to 462 inclusive. Page 387.

Fig. 448. The primary, a cube.

Figs. 449, et seq.

P on *d*	.....	152°	15′ 52″
P on *e*	.....	153	26 15
P on *f* or *f′*	.....	143	18 2
P on *o*	.....	144	44 8
d on *d* over the base,		109	28 16
d on *f*	.....	157	47 33
e on *e*	.....	126	52 12
e on *e′* or *e″*	.....	113	34 41
o on *o′* or *o″*	.....	146	26 33

Fig. 442.

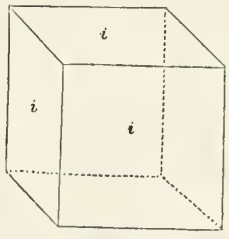


Fig. 443.

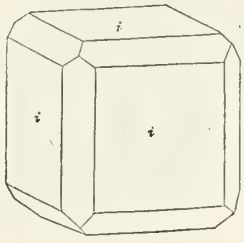


Fig. 444.

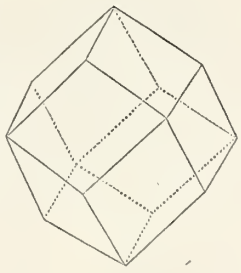


Fig. 445.

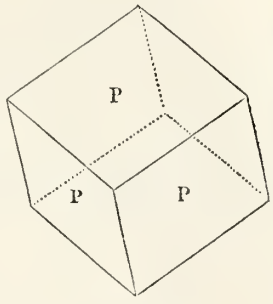


Fig. 446.

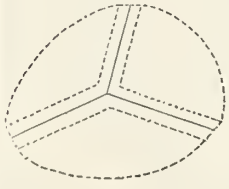


Fig. 447.

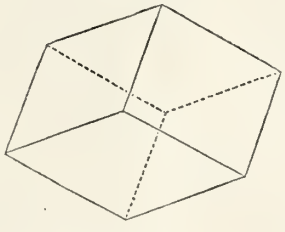


Fig. 448.

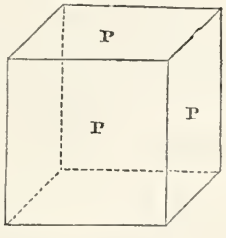


Fig. 449.

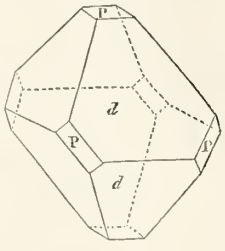


Fig. 450.

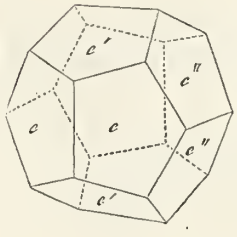


Fig. 451.

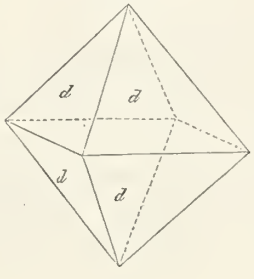


Fig. 452.

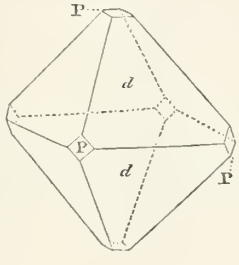


Fig. 453.

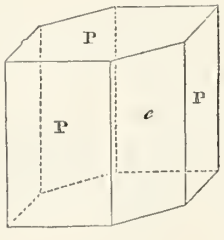


Fig. 454.

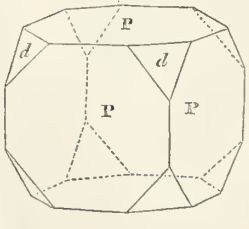


Fig. 455.

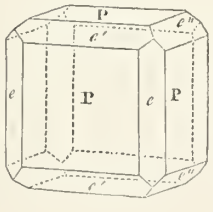


Fig. 456.

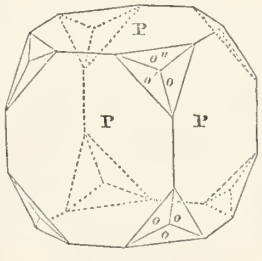
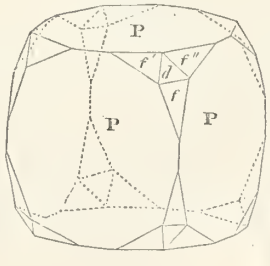


Fig. 457.



IRON PYRITES. (Continued.)

Figs. 461 and 462.

P on d	152°15′ 52″
P on e	153 26 5
d on e	140 46 7
e on e	126 52 12
e on e' or e''	113 34 41

MAGNETIC IRON PYRITES. Fig. 463. Page 392.

Fig. 363. The primary, a regular six-sided prism.

WHITE IRON PYRITES. Figs. 464 to 466 inclusive. Page 393.

Fig. 464. The primary, a right rhombic prism.

M on M′	106° 2′

Fig. 465.

P on c	160°48′

Fig. 466. A compound crystal made up of five individuals.

a on c	141°30′

ARSENICAL IRON PYRITES. Figs. 467 to 470 inclusive. Page 394.

Fig. 467. The primary, a right rhombic prism.

M on M′	111°18′

Figs. 468, et seq.

M or M′ on a	136°20′
M or M′ on l	115 32
l on l	80 24
l on z	160 49
z on z	118 46

SCORODITE. Fig. 471. Page 396.

Fig. 471. The primary, a right rhombic prism.

M on M′	120°10′

SPATHOSE IRON. Fig. 472. Page 397.

Fig. 472. The primary, a rhombohedron.

P on P′	107° 0′

ANKERITE. Fig. 473. Page 398.

Fig. 473. The primary, a rhombohedron.

P on P′	106°12′

Fig. 458.

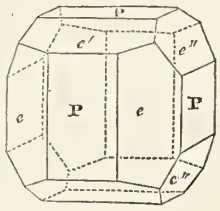


Fig. 459.

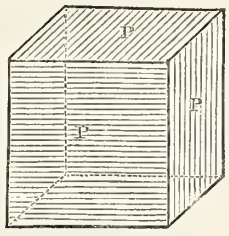
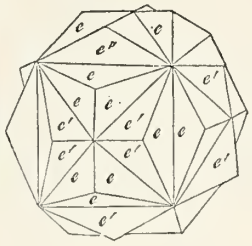


Fig. 460.



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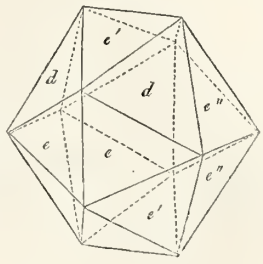

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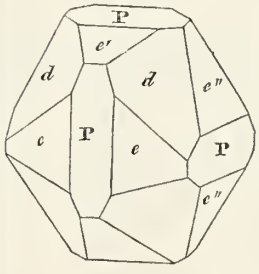

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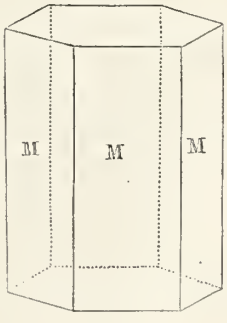


Fig. 464.

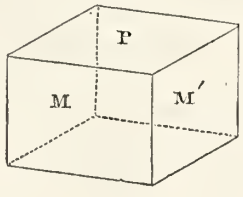


Fig. 465.

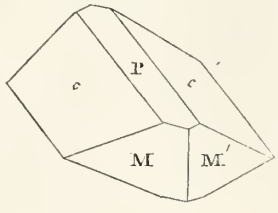


Fig. 466.

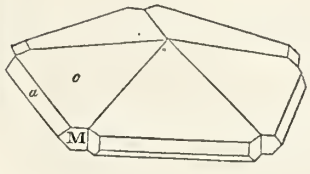
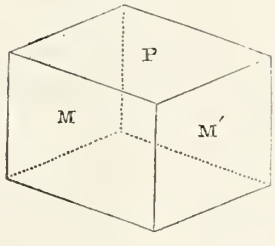


Fig. 467.



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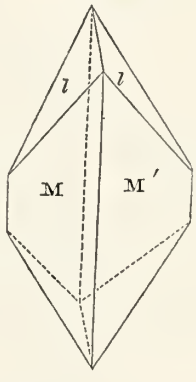
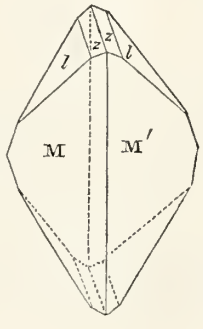


Fig. 469.



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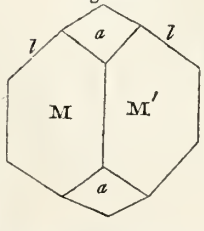
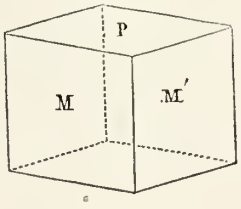


Fig 471.



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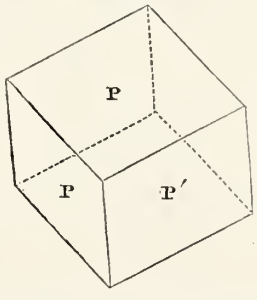
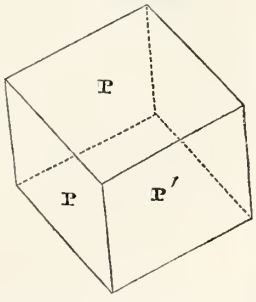


Fig. 473.



COPPERAS. Fig. 474. Page 399.

Fig. 474. The primary, an oblique rhombic prism.

M on M′ ..... 82°21′
M on P 99 23

CHROME-IRON ORE. Figs. 475 and 476. Page 400.

Fig. 475. The primary, a regular octahedron.

P on P′ ..... 109°28′ 16″

Fig. 476. A modification of the same, found at Hoboken, New-Jersey.

P on *o* ..... 144°44′ 8″

VIVIANITE. Fig. 477. Page 401.

Fig. 477. The primary, a right oblique angled prism.

M on T ..... 125°18′

ILVAITE. Fig. 478. Page 403.

Fig. 478. The primary, a right rhombic prism.

M on M′ ..... 112°37′

SILICATE OF IRON (artificial). Fig. 479. Page 404.

T on *k* ..... 138°31′
T on *n* 114 6

MANGANESE SPAR. Fig. 480. Page 406.

Fig. 480. The primary, a doubly oblique prism.

M on P ..... 93° to 94°
M on T 121

BABINGTONITE. Figs. 481 and 482. Page 407.

Fig. 481. The primary, a doubly oblique prism.

M on P ..... 92°34′
M on T 112 30
P on T 88 0

Fig. 482.

g on *m* ..... 132°15′
h on *m* 137 5
h on *t* 155 25

ZINC BLENDE. Figs. 483 to 487 inclusive. Page 408.

Fig. 483. The primary, a rhombic dodecahedron.

P on P ..... 120° 0′ 0″

Figs. 484, et seq.

g on *g*′ ..... 70°31′ 44″
g on *m* or *g*′ on *m*′ . 109 28 16

GALENA. Figs. 488 to 495 inclusive. Page 412.

Fig. 488. The primary, a cube.

Fig. 474.

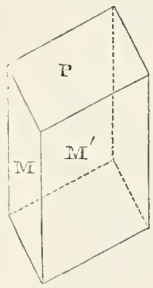
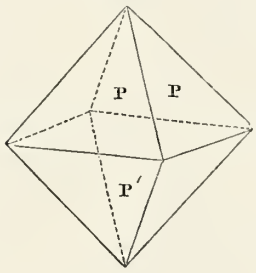


Fig. 475.



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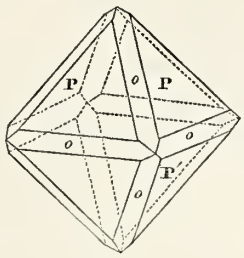


Fig. 477.

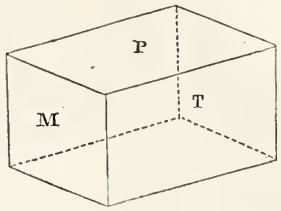


Fig. 478.

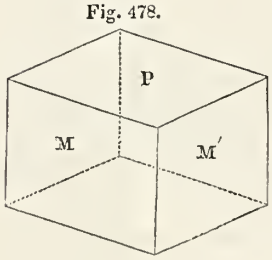


Fig. 479.

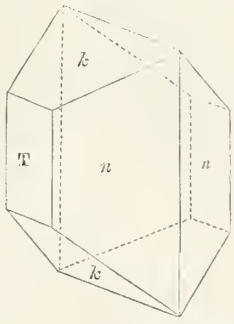


Fig. 480.

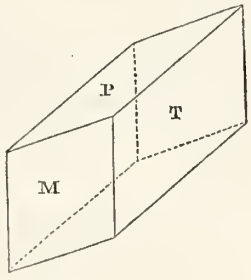


Fig. 481.

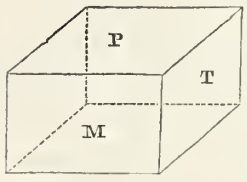


Fig. 482.

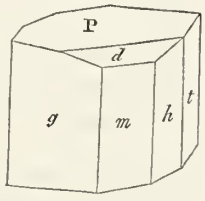


Fig. 483.

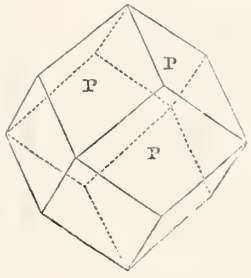


Fig. 484.

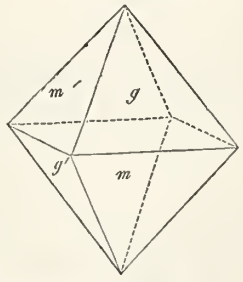


Fig. 485.

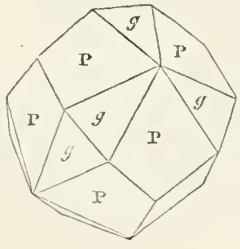


Fig. 486.

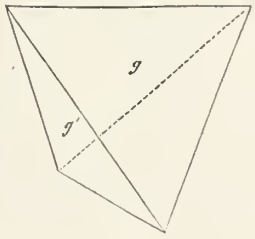


Fig. 487.

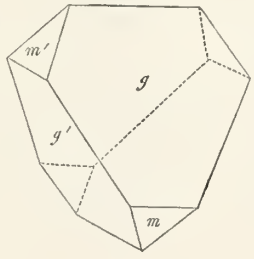
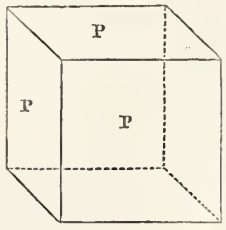


Fig. 488.



GALENA. (Continued.)

P on *c* ..... 125°15′ 52″
c on *c* 109 28 16

Fig. 493. A compound crystal. Orange county.

WHITE LEAD ORE. Fig. 496. Page 414.

Fig. 496. The primary, a right rhombic prism.

M on M′ ..... 117° 0′

ANGLESITE. Fig. 497. Page 415.

Fig. 497. The primary, a right rhombic prism.

M on M′ ..... 103°42′

YELLOW LEAD ORE. Fig. 498. Page 416.

Fig. 498. The primary, an octahedron with a square base.

P on P′ ..... 131°15′
P on P 99 50

PYROMORPHITE. Fig. 499. Page 417.

Fig. 499. A secondary form.

M on M′ ..... 120° 0′
M on P 90 0

PYROMORPHITE.

M on *c*′ or M′ on *c*″ .. 131 45
M or M′ on *d*′ 150 0
P on *c* or *c*′ 138 30
c′ on *c* or *c*″ 110 5

VAUQUELINITE. Fig. 500. Page 418.

Fig. 500. A compound crystal.

P on P′ over the summit, 134°30′
P on *h* 149 0

NATIVE BISMUTH. Fig. 501. Page 419.

Fig. 501. The primary, a regular octahedron.

NATIVE COPPER. Fig. 502. Page 420.

Fig. 502. The primary, a cube.

RED COPPER ORE. Fig. 503. Page 421.

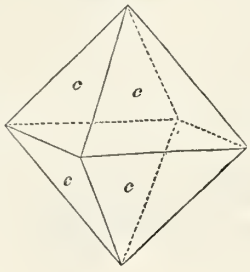
Fig. 503. The primary, a regular octahedron.

VITREOUS COPPER. Fig. 504. Page 422.

Fig. 504. The primary, a right rhombic prism.

M on M′ ..... 119°35′

Fig. 489.



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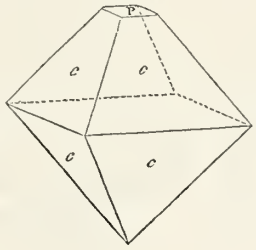


Fig. 491.

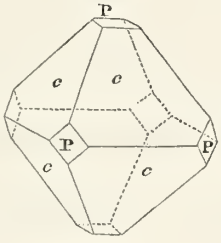


Fig. 492.

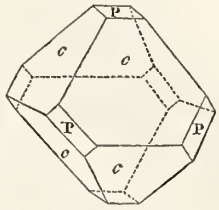


Fig. 493.

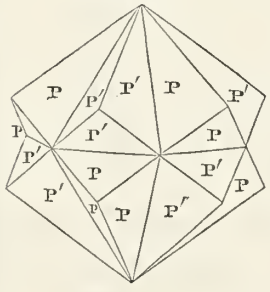
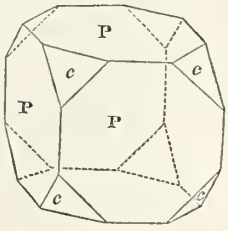


Fig. 494.



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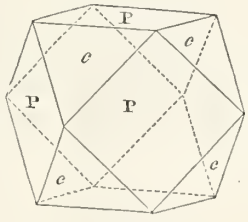


Fig. 496.

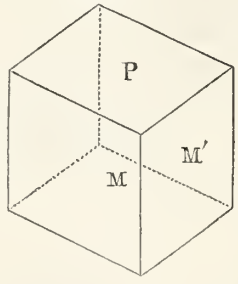
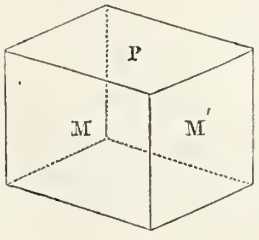


Fig. 497.



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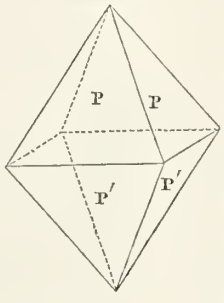


Fig. 499.

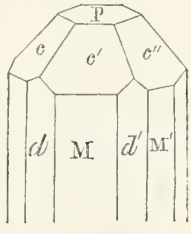
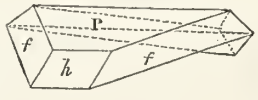


Fig. 500.



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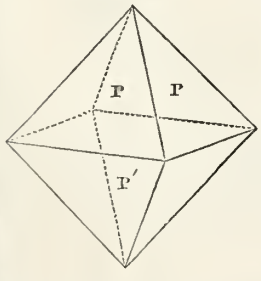

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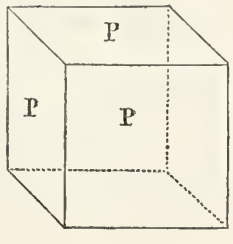

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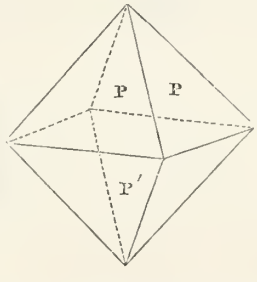
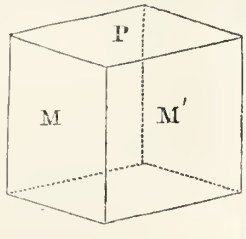


Fig. 504.



COPPER PYRITES. Figs. 505 to 508 inclusive. Page 423.

Fig. 505. The primary, an octahedron with a square base.

P on P′ ..... 125°30′
P on P or P′ on P′ ... 102 30

Fig. 506.

l on *l* ..... 71°10′

Fig. 507. A twin, composed of about equal parts of an octahedron, one half of which is turned round. St. Lawrence county.

Fig. 508.

P on *c* ..... 140°30′

AZURITE. Fig. 509. Page 426.

Fig. 509. The primary, an oblique rhombic prism.

M on M′ ..... 98°50′
M or M′ on P 91 30

ANATASE. Fig. 510. Page 428.

Fig. 510. The primary, an octahedron with a square base.

P on P′ ..... 136°47′
P on P or P′ on P′ ... 98 5

RUTILE. Figs. 511 to 515 inclusive. Page 428.

Fig. 511. The primary, a right square prism.

RUTILE.

Fig. 512. A jointed crystal formed by the union of two four-sided prisms.

s on *s* ..... 126°52′

Figs. 513, et seq.

M on *l* ..... 135° 5′
M on *s* 161 40
l on *r* 132 20
l on *s* 153 33
r on *r* 123 15
r on *u* 151 42

ILMENITE. Figs. 516 to 518 inclusive. Page 431.

Fig. 516. The primary, a rhombohedron.

P on P ..... 85°59′

Figs. 517 and 518.

P on *a* about ..... 128° 0′
P on *b* or P′ on *b* 123 14

SPHENE. Figs. 519 to 528 inclusive. Page 433.

Fig. 519. The primary, (according to Beudant), an oblique rhombic prism.

M on M′ ..... 133°30′
M or M′ on P 121 50

Fig. 520. The primary, (according to G. Rose.)

M on M′ ..... 76° 2′
M or M′ on P 93 1

Fig. 505.

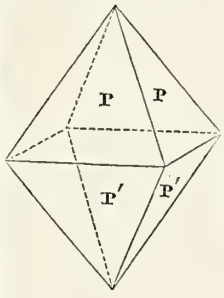


Fig. 506.

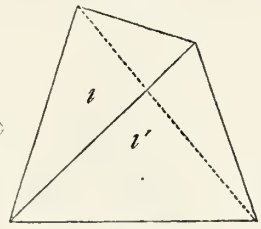
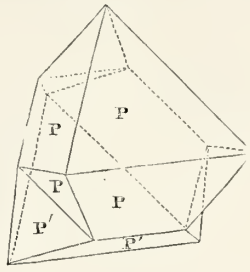


Fig. 510.

Fig. 507.



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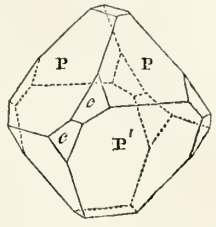


Fig. 512.

Fig. 509.

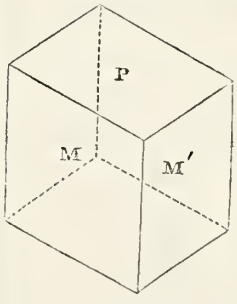


Fig. 513.

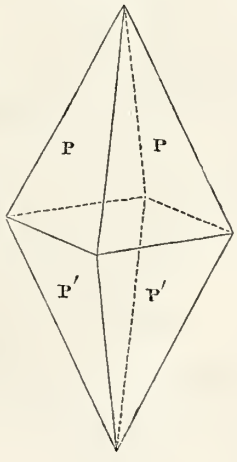
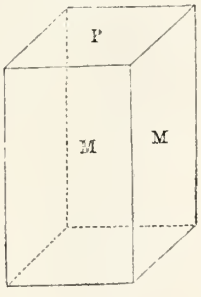


Fig. 511.



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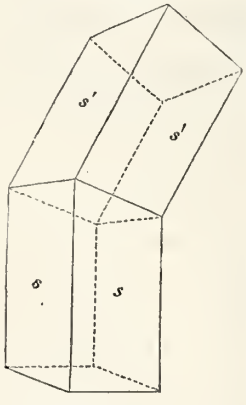
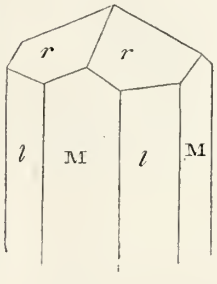
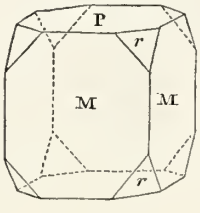
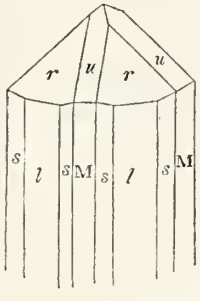


Fig. 516.

Fig. 514.







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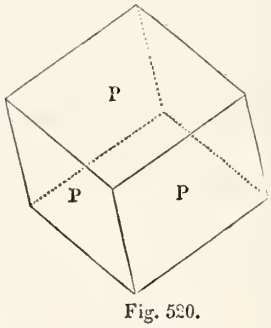
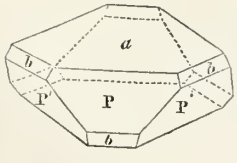


Fig. 520.

Fig. 517.



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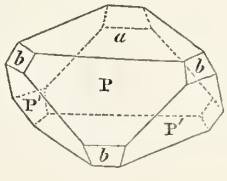
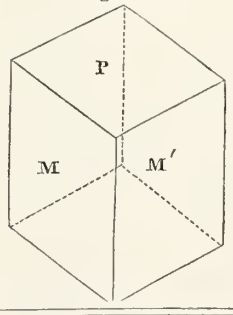
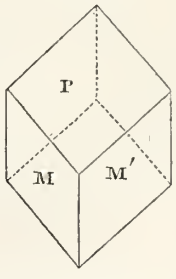






SPHENE. (Continued.)

Figs. 521, et seq.

M or M′ on a	139°30′
P on a	159 44
P on c	140 52
P on e_2	158 18
P on e_4	146 30
c on d_1	146 44
c on e_2	145 18
c on e_4	154 52
d_1 on d_1	113 24
d_2 on d_2	136 0
e_2 on e_2	136 50
e_4 on e_4	113 40

WARWICKITE. Figs. 529 and 530. Page 436.

Fig. 529. The primary, an oblique rhombic prism.

M on M′ ..... 93° to 94°

WARWICKITE.

Fig. 530. A modification of the preceding.

MOLYBDENITE. Fig. 531. Page 438.

Fig. 531. The primary, a regular six-sided prism.

M on M ..... 120° 0′

ORPIMENT. Fig. 532. Page 439.

Fig. 532. The primary, a right rhombic prism.

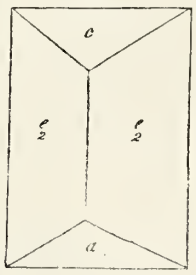
M on M′ ..... 100° 0′

ALLANITE. Fig. 533. Page 440.

Fig. 533. A secondary form.

M on P about	115°
M on r	128
P on r	116

Fig. 521.



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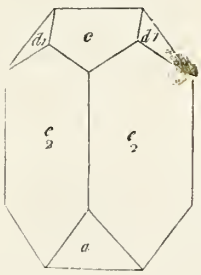

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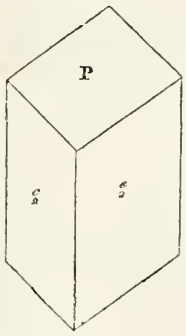

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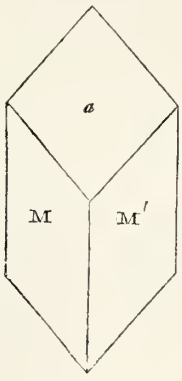

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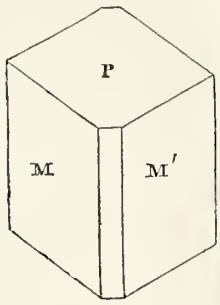

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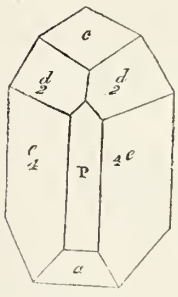

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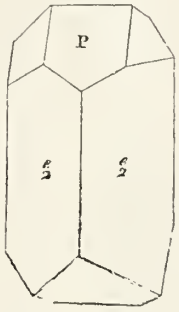

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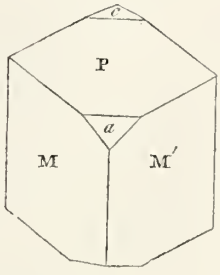

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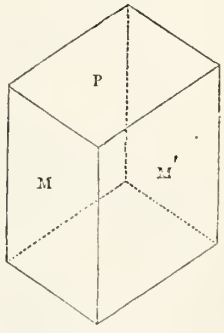

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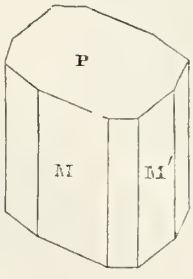

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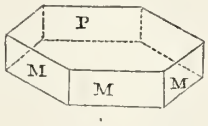

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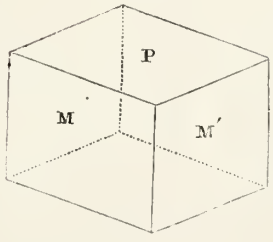

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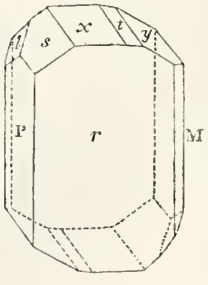

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ERRATA.

Page 29. Among the synonymes of Hydrous Peroxide of Iron, for "Rhombohedral Iron Ore, *Jameson*," and Rhomboedrisches Eisen-Erz, *Mohs*," read "Prismatic Iron Ore, *Jameson*, and Prismatisches Habronem-Erz, and Prismatoidisches Habronem-Erz, *Mohs*."

Page 205, 4th line from the bottom, for "P on *o* 137° 5′ 13″," read "P on *o* 127° 5′ 13″."

Page 247, 19th line from the bottom, for "*o* to the edge between *f*," read "P to the edge."

Page 290. At the top, for "Fig. 194," read "Fig. 194 *bis*."

Page 301, 10th and 11th lines from the bottom, for "*k* on *k* 55° 4′," read "*k* on *k* 155° 4′."

Page 302, 7th line from the bottom, for "Fig. 223," read "Fig. 223 *bis*."

Page 474. The reference "page 257" should be "page 247."

Page 477, 1st line, for "Mag. Carb. of Magnesia and Qurtz," read "Magnesian Carbonate of Lime and Quartz."

EXPLANATION OF ADDITIONAL PLATES.

PLATE I. A Section of Ball's Cave, in Schoharie county. From Mr. MATHER. (See page 227 of this volume.)

PLATE II. Plans and Sections of the Shawangunk Lead Mine, near Wurtzboro', in Sullivan county. From the drawings furnished by Mr. COTHEAL, of New-York. (See pages 50 and 414.)

PLATE III. View of the Coal Hill or Rossie Lead Mine, in Rossie, St. Lawrence county, as it appeared in the summer of 1836. (See pages 48 and 413.)

PLATE IV. Map of the Lead Vein in Rossie, St. Lawrence county. (See the pages just referred to.)

PLATE V. Ground Plan of the Beds and Veins of Magnetic Iron Ore, or Magnetic Oxide of Iron, at Adirondack, Essex county. (See page 16.)

PLATE VI. Map of Mining District of Monroe, Orange county. Reduced from the copy furnished by PETER TOWNSEND, Esq. (See page 5.)

PLATE VII. View of the Strata of Potsdam Sandstone, (composed chiefly of quartz,) as exhibited at the "Walled Banks," about four miles from the village of Keeseville, Essex county.

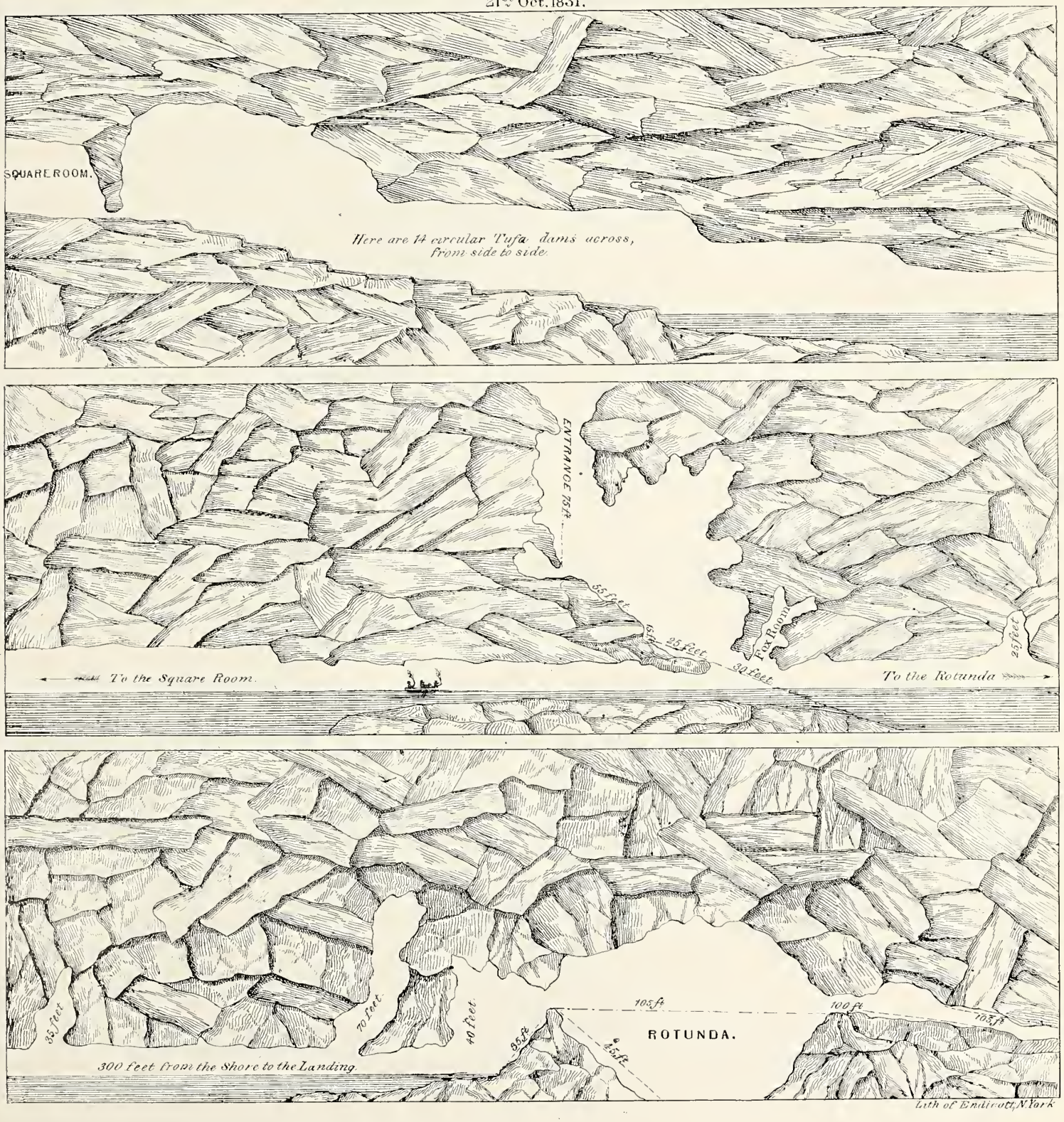
PLATE VIII. Hopper-form cavities and crystals of Marly Clay, at Bull's Quarry, Madison county, and at Camillus, Onondaga county. (See page 119.)

BALLS CAVE,

SCHOHARIE COURT HOUSE.

1st From the Entrance to the Square Room or North end, is about half a Mile in length.—
was Explored by
JOHN GEBHARD, ESQr. & JOHN S. BONNY.
30th May 1832.

2nd From the Entrance to the Rotunda or South end
Explored by
JOHN GEBHARD, ESQ. Dr. JOEL FOSTER, & JOHN S. BONNY,
21st Oct. 1831.

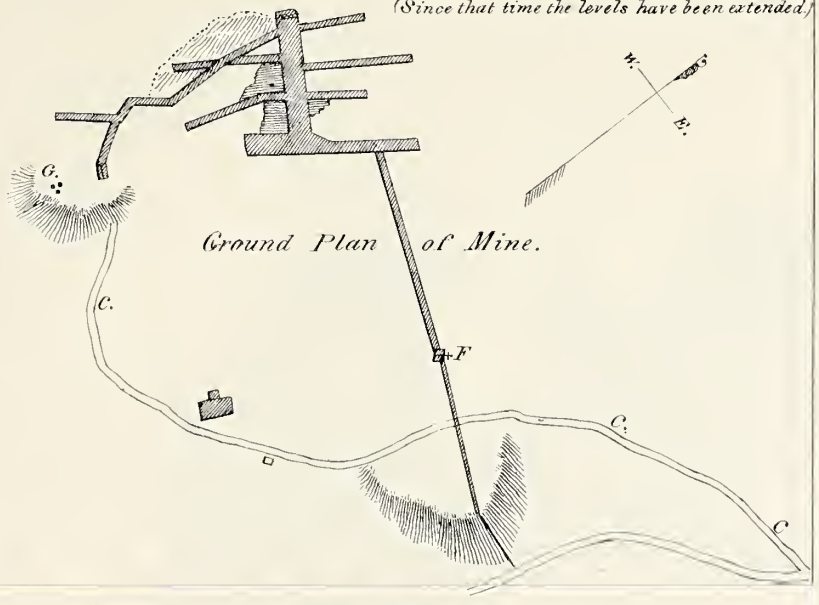


Lith of Endicott, N York

SHAWANGUNK LEAD MINE.

Surveyed by John Hitz, in May 1840.

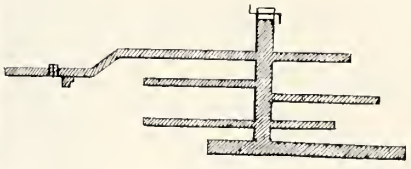
(Since that time the levels have been extended.)



Ground Plan of Mine.

C. Road from Smelting House to Mine.
F. Opening to South in lowest Level
G. d° to North Level.

Vertical Section of Mine.



SCALE OF FEET.

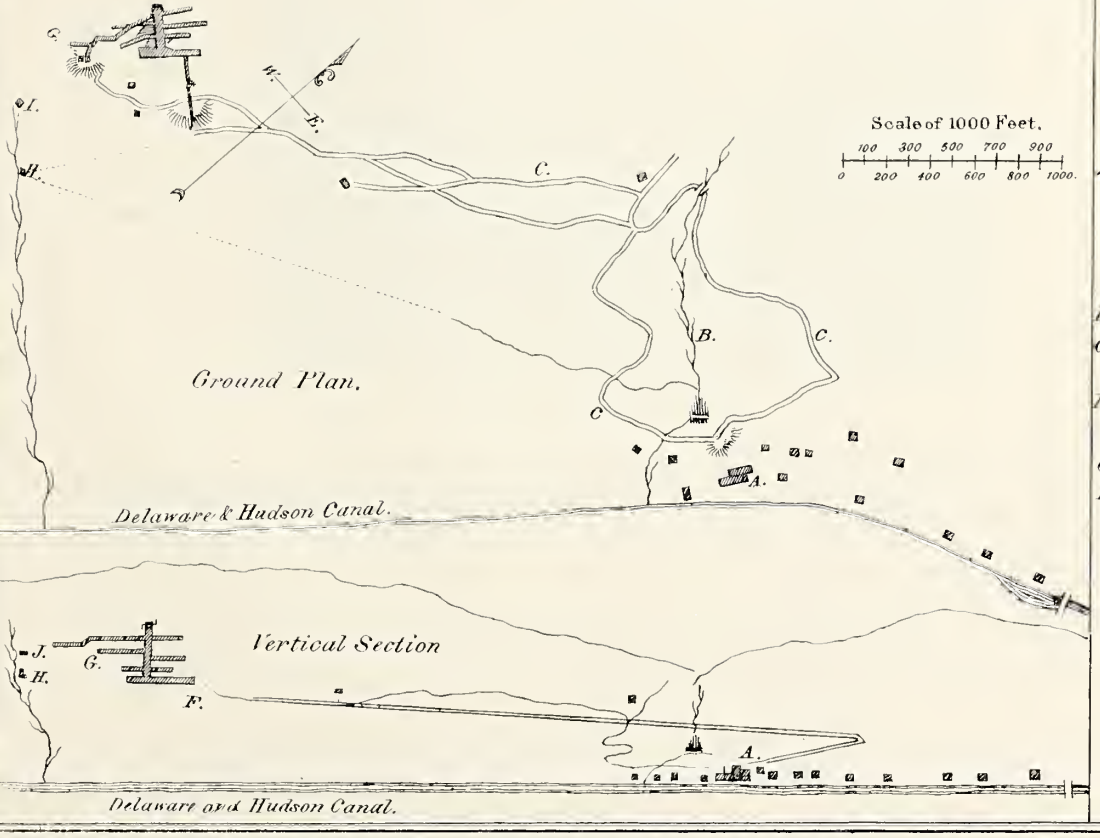
100 50 0 100 200 300 400 500 600 700

SHAWANGUNK LEAD MINE.

Surveyed by John Hitz.

in May 1840.

(Since that time the levels have been extended.)



Ground Plan.

Vertical Section

Scale of 1000 Feet.

100 300 500 700 900
0 200 400 600 800 1000.

A. Smelting-House, Engine-House & blowing Cylinders, Stamping House, Labyrinth & Washing tables.
B. Stream of Water & Dam.
C. Roads from Smelting house to Mine.
F. Opening to South or Lower level.
G. Opening to North Level.
H.I. Proposed opening to new Levels.

Lith. of Endicott N.Y.

PLATE III.

Coal Hill Mine, Rossie, St. Lawrence county.

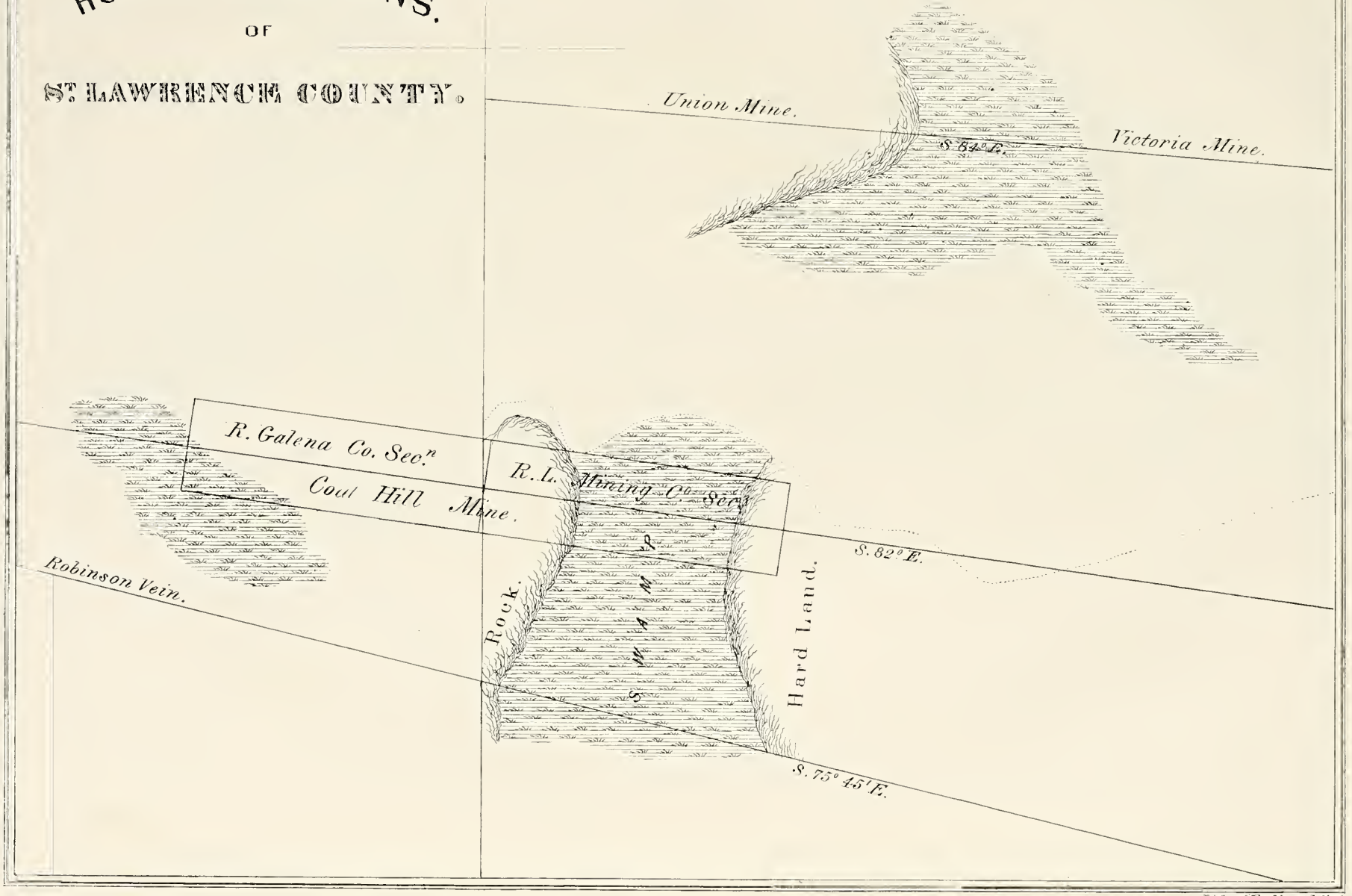
This mine is described on page 48 of this volume, under the name of the *Rossie Lead Mine*, and the above sketch represents its appearance in the early part of the year 1836. The cut is introduced from Dr. Emmons' Report.

PLATE 4.

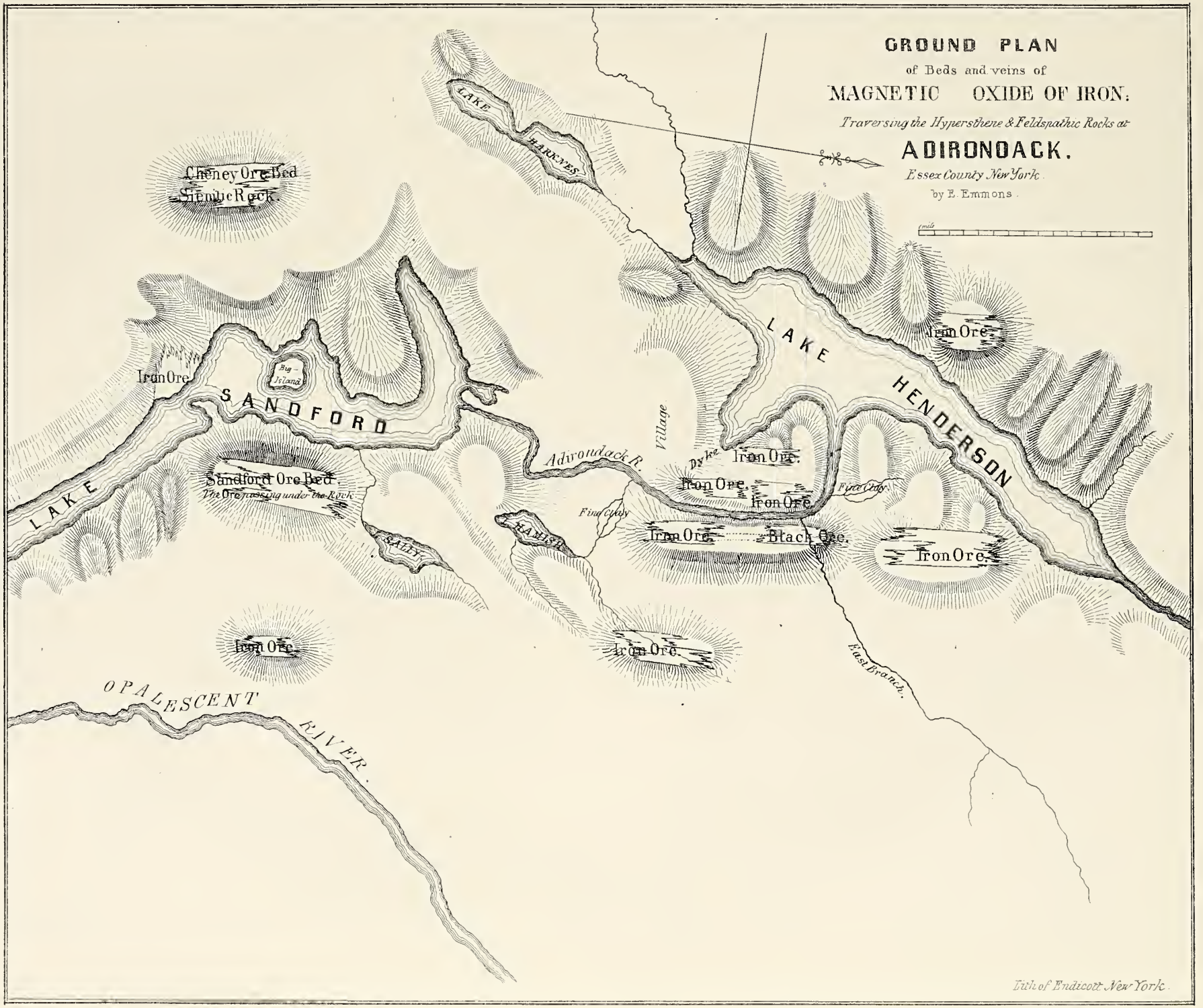
ROSSIE LEAD VEINS.

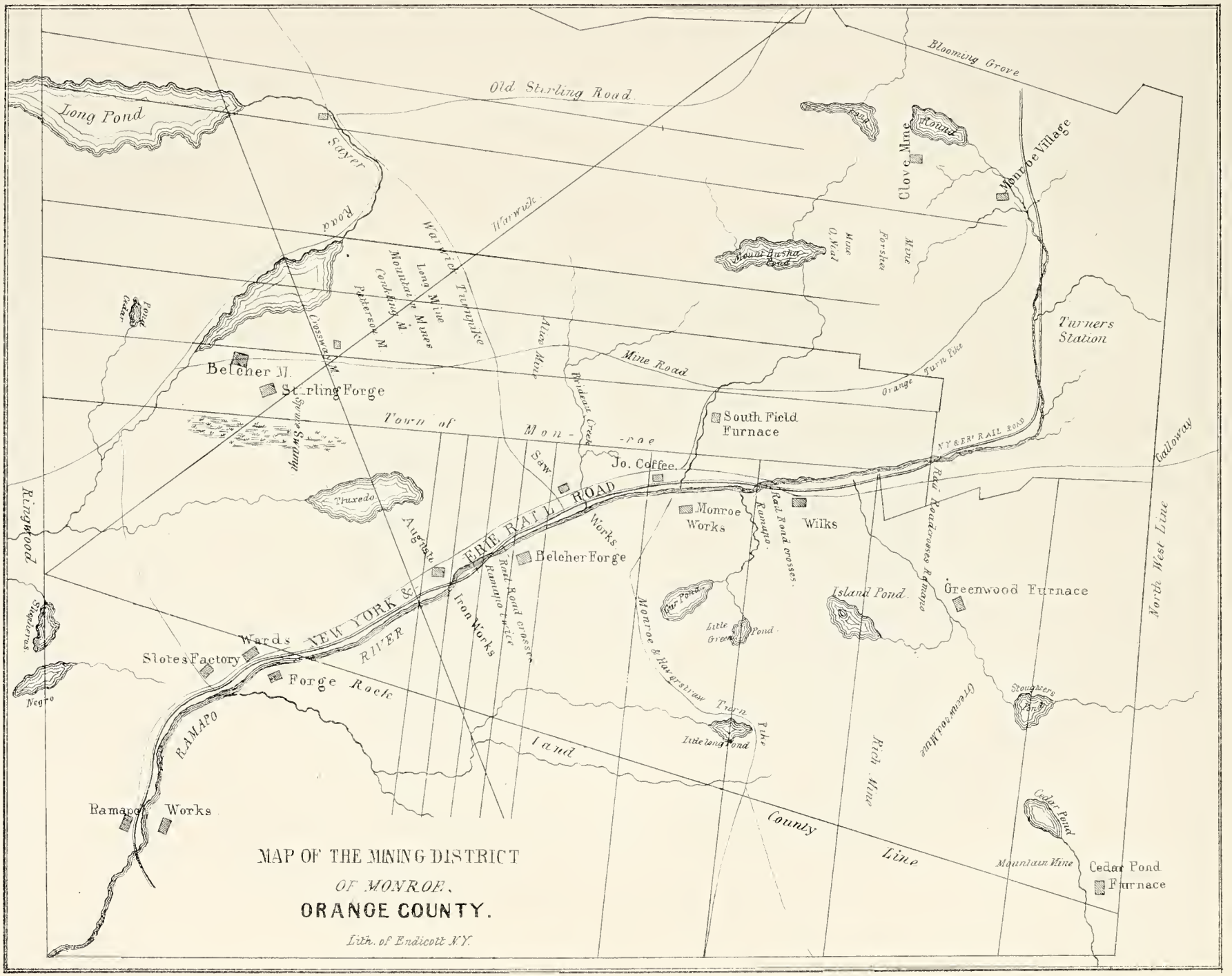
OF

ST. LAWRENCE COUNTY.



Lith. of Endicott, N. York


GROUND PLAN
of Beds and veins of
MAGNETIC OXIDE OF IRON.
Traversing the Hypersthene & Feldspathic Rocks at
ADIRONDACK.
Essex County New York.
by E. Emmons.
Cheney Ore Bed
Steatite Rock.
LAKE
HARRIES.
LAKE
HENDERSON
Iron Ore.
Iron Ore.
Big Island
SANDFORD
Adirondack R.
Village
Sandford Ore Bed.
The Ore rises Dig under the Rock
LAKE
Fine Clay
Fine Clay
Iron Ore.
Iron Ore.
Iron Ore.
Black Ore.
Iron Ore.
HAMLET
BALBY
Iron Ore.
Iron Ore.
East Branch.
OPALESCENT
RIVER.
Lith of Endicott New York.



MAP OF THE MINING DISTRICT

OF MONROE,

ORANGE COUNTY.

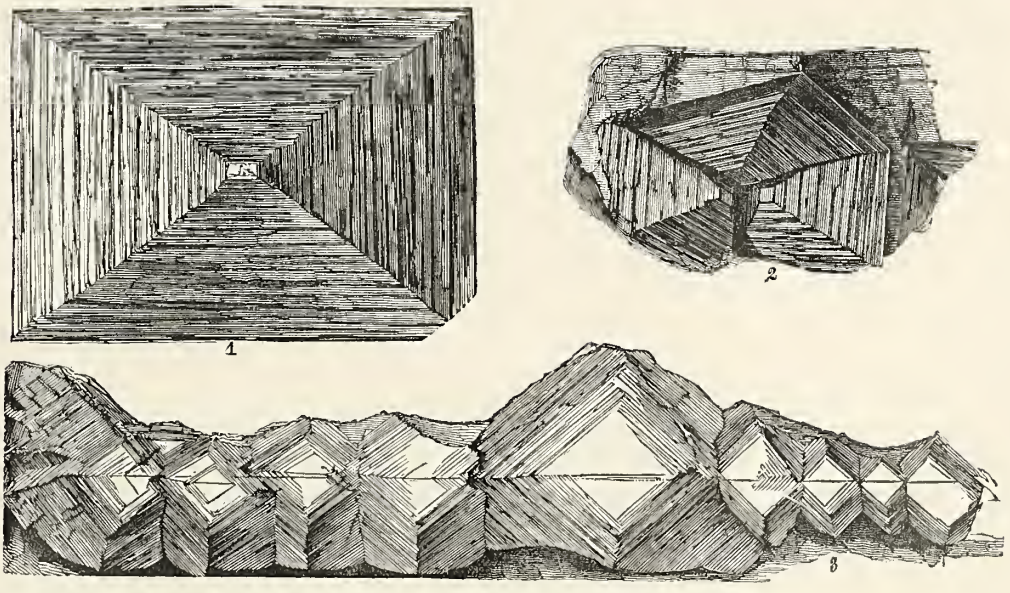
Lith. of Endicott N.Y.

PLATE VII.

View of the Potsdam sandstone near Keeseville, Essex county. (*From* Dr. EMMONS' *Report.*)

This rock is chiefly composed of quartz.

PLATE VIII.



Hopper-shaped cavities of various forms, from Bull's Quarry, in the town of Lenox, Madison county. (*From* Mr. VANUXEM'S *Report.*)

Near the village of Camillus in Onondaga county, there is a stratum made up of similar cavities, and crystals corresponding to them. Descriptions of these will be found on page 119 of this volume.

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